THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 39. Thursday, December 27, 1928. No. 645.

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (4 lines).

Contents.

	PAGE
Retrospective	463
Correspondence	464
Random Shots	464
Metallurgy of Steel Castings	465
Vickers - Vickers-Armstrongs - Cammell-Laird Steel Fusion	466
Electric Furnace Developments	467
Institute of British Foundrymen	469
Specifications for High-Grade Cast Iron	472
The Electric Drive in Patternshops	472
Production and Properties of Magnesium Alloy Castings	473
The Application of Welding in Iron and Steel Works	476
Trade Talk	478
Company Meetings	478
Personal	478
Reports and Dividends	478
New Companies	478
Contracts Open	478
A Foundry Owner's Christmas Charity Fund	480
European Steel Syndicates	480
Obituary	480
Iron and Steel Markets	480

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.
PRESIDENT: 1928-29:
S. H. Russell, Bath Lane, Leicester.
LIST OF SECRETARIES—
General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office, 49, Wellington Street, London, W.C.2.
Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, 26, Castlewood Road, Fulwood, Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: H. Stead, 1st/36, Cheetham Hill Road, Stalybridge, Cheshire.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: F. Sanderson, 10, Westgate Road, Newcastle-on-Tyne.
East Midlands: H. Bunting, 82, Otter Street, Derby.
West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.
Middlesbrough: N. D. Ridsdale, 3, Wilson Street, Middlesbrough.

Foundry Trades Equipment & Supplies Association.
President: H. Winterton,
Kelvinvale Mills, Maryhill, Glasgow.
Secretary: K. W. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Welsh Engineers' and Founders' Association.
Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION.
The Registered Office and Laboratories of the B.C.I.R.A. are at:
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*)

Forthcoming Events.

Institute of British Foundrymen.
JANUARY 4.
London Branch (Junior Section):—Ordinary meeting in London. Paper by V. C. Warren.
JANUARY 5.
West Riding of Yorkshire Branch:—Meeting at Bradford. Discussion on "Foundry Costs," opened by W. G. Thornton.
Lancashire Branch:—Ordinary meeting at Manchester. "Wood Patterns from the Pattern Makers' and Moulders' Points of View," Paper by F. C. Edwards.
JANUARY 8.
Birmingham Branch:—Joint meeting at Dudley. "Centrifugal Cast Iron Pipe," Paper by E. J. Fox and P. H. Wilson.

Retrospective 1928.

The year now rapidly drawing to a close is, so far as general trade is concerned, one of the most difficult to analyse. When the final analysis is made, however, we believe its most important aspect will be characterised by some term synonymous with "incipient rationalisation." In 1913 it was not unusual for two labourers earning 4¾d. per hour to take two hours to fetch a ladder from an adjoining shop, whilst to-day 10 minutes would have to suffice. Thus the cost has been reduced from 1s. 7d. to about 4d. Whilst the unemployment returns now stand at 1,300,000, as against just over 1,000,000 for 1927, yet trade, as exemplified by the Board of Trade Returns, has at least kept at the same level. Again, the disbursements made by the local poor relief authorities, we believe, are now substantially less.

For several years we have been able to congratulate the foundries catering for the builders' merchants on the continuance of their prosperity, but this year there has been a general setback. The bottom has fallen out of the rainwater-goods market due to cut-throat competition for the reduced business being placed. The general average price level of builders' castings on the international market has fallen by £1 9s. 2d. per ton as compared with last year, whilst there has been nothing of an ameliorative character. Mr. Scotland, in a recent important speech, stressed the disability placed upon Falkirk, the centre of the industry, consequent upon geographical situation rendering transport costs—associated with breakage losses—unduly high. The progress of the new foundry shortly to be opened at Greenford, Middlesex, where, *inter alia*, bath tubs are to be manufactured, will be watched with interest as a further instance of the gravitation of industry southwards. The Scottish foundries this year have been buying pig-iron from the Midlands at a price competitive with Cleveland, whilst quotations from both these districts have been sufficiently favourable to exclude completely the use of Continental iron.

The great British pipe founders have made commendable technical progress, but they have not been excessively busy. Unfortunately the product of these foundries is materially above the standard demanded by many foreign buyers, and they naturally hesitate before lowering quality. We are convinced that the majority of foreign pipes sold on the international market would not pass British standard specifications. It thus appears evident that they should take steps to meet overseas market conditions by lowering price and quality or teach the overseas buyers the true economies to be effected by using British standard material. The export of cast-iron pipes has declined by about 9 per cent. as compared with 1927, whilst the price received is 2s. per ton lower. These are the only two sections of the iron-foundry industry for which statistics are available, and we confess that the balance of our review in this respect is largely hearsay and deduction.

The marine engineering foundries have certainly had more work than for many years past, though there is still ample floor space available for increased business.

The great electrical engineering foundries have experienced conditions parallel with those of 1927. The full force of the amalgamations in the industry of the last year have not been felt at the foundry end of the firms concerned.

So far as the textile foundries are concerned, bad trade has again been the general rule, except those catering for the artificial silk section of the industry, from which many good orders have been placed. One of the chief artificial silk factories had the intention of installing its own foundry, but recent information announces the postponement of this development. We think this can be associated with the reception of highly satisfactory castings from existing foundries.

The railway castings foundries have been poorly supported, but better conditions in the future seem probable.

Whilst the agricultural implement foundries have never really recovered from the loss of business consequent upon the aftermath of the war, their output has been better this year.

The automobile foundries have been irregular. Some have done good business, whilst others have been extremely slack. The Rover Company has closed down its foundry, whilst the Morris concern is creating new shops for this purpose. Ford, too, contemplates the construction of an entirely new concern at Dagenham.

The foundries catering for the printing industry have maintained an even keel, whilst those relying on the mining industry, though better employed than in 1927, have still much leeway to make up.

The non-ferrous foundry industry has had a remarkably good year. Engineers are taking more and more interest in the light alloy section of the industry, because of the wonderful strength per unit weight figures now available. It seems that the use of magnesium and aluminium-silicon alloys is increasing. We suggest that more attention should be paid to free-machining brass, as certain overseas engineers consider this of paramount importance for many jobs not requiring high strength properties.

The steel-foundry industry has fallen away somewhat this year, and the monthly outputs are in general slightly less than 1927. This is rather surprising, as the importation of steel castings has been considerably less than 1927. It is probable that drop stampings are creating serious competition.

The Institute of British Foundrymen continues to make solid progress. Its president, Mr. S. H. Russell, typifies the modern non-specialised industrialist, who appreciates dispassionately the academic, technical, and practical aspects of the foundry trade. His speeches are invariably erudite and constructive. His presidency over the Leicester Conference was a model worthy of emulation by those who serve their branches in a similar capacity and those who will succeed them in the chair. For next year's international conference—a subject which will be dealt with in our next issue—much quiet spadework has already been done. The Institute was represented at the First

XUM

Spanish Foundry Congress—a wonderfully successful effort—by its secretary, Mr. Tom Makemson, and Mr. V. C. Faulkner, a past-president. Dr. Everest's Paper on nickeliferous cast iron was accorded a highly sympathetic reception. The "French Exchange Paper," presented by Dr. Donaldson to a recent Paris conference, was generally conceded to be the most important thesis presented, whilst Mr. John Shaw's Paper, given to the American Association, was one of his typical efforts which are designed to draw forth a maximum amount of discussion.

The work of the Cast Iron Research Association is conveniently divided into two sections. In the first place there is that work which is done by the Association for its own members, and which does not call for consideration in a review of this description. There is, however, a considerable amount of work done by the Association which is published for general use. We believe that through this work the Association recognises its public responsibilities to the industry as a whole, and it is also probably actuated by the very human motive of wanting to show the industry some of the things that it can do, in the hope of extending the support it gets from the trade. We have previously referred at some length to three papers issued during the current year by Mr. Pearce on the test-bar problem. There is no need to deal with this matter therefore, beyond stating that this is a fundamental problem to the industry, as the bulk of the output of castings which is subjected to any sort of inspection or test is controlled by test bars, and nothing the industry is likely to do within the next few years will alter this system. It is possible that at the June Convention Dr. Norbury will present a paper on the influence of manganese in cast iron, which does make an important contribution towards clearing up the present mass of contradictions which surround the subject.

As the result of several years' research, the American Foundrymen's Association has issued an important report on specifications and tests for moulding sands, and this has had so much influence in France that the French methods are practically a copy of the American. A certain amount of German work is being made public, and we believe that in the near future the work of the Cast Iron Research Association will put this country at least in as good a position as America or Germany. The sand deposits of this country are quite different from those of U.S.A., and the Association avoided the mistake of copying American procedure, although this would have been a much shorter cut. However much we may appreciate American papers on sands, the methods found necessary there will not serve on this side.

One of the more important results of the general work of the Association has been the steady popularising of the new B.E.S.A. specifications. The Association has consistently supported and advocated the new specifications for grey and malleable iron, and we regard with very considerable dismay recent attempts to discredit the grey-iron specification. Every reformer knows that a step forward is never as great as he would like. He has to compromise, and founders will never get their deserts from engineers until they can stand together technically on a united front. While these divisions are evident between founders themselves, engineers will continue to play off one section against the other, to the disadvantage of both. The buyer is usually a more keen diplomatist than the seller.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Graphite in Cast Iron.

To the Editor of The Foundry Trade Journal.

Sir,—I was unfortunately unable to be present when Mr. Shaw read his valuable Paper, but have scanned with interest the discussion published in your issue of December 13.

It astonishes me to see metallurgists yet arguing as to whether the size of graphite does or does not affect the tensile strength. We do not know whether what we call graphite *is* graphite and until we do, the above point is a hopeless one to discuss. An all-pearlitic cast iron containing, say, 2.9 per cent. of graphite can be stronger—I have seen many examples of it—than an all-pearlitic iron containing, say, 1.9 per cent. of graphite. Hence, if one iron is as strong as or stronger than another iron containing 1 per cent. less graphite, it follows that there is something which we do not understand and until we do it seems futile to compare strength with graphite-size.

I note with pleasure Mr. Pearce's suggestion concerning the use of chill-cast pig-iron. Of course there is no difficulty about using it. Any experienced foundry metallurgist would be only too glad to have the chance. Talking about grading by fracture, I had an interesting talk the other day with a blast-furnace manager. He told me it was impossible to grade by fracture, and that could it be done it would save him the cost of thousands of analyses per annum. He met recently a foundryman who claimed to be able to do it and invited him to come to his blast-furnace stockyards to try his skill upon some thousands of tons of irons there. He guaranteed the man a good salary if he could prove his ability to tell even the approximate silicon-content. The challenge was not accepted.

There would appear to be an opportunity for the British Cast Iron Research Association to conduct a valuable research upon the vexed question as to whether graphite and the size of the graphite in the cupola-charge affects the graphite of the iron tapped. Suppose they took fifty tons of ordinary pig-iron as tapped from the blast furnace and containing, say, 1.75 per cent. of silicon and poured one-half of it into thin-pig chill-moulds (chilled drastically so that the pigs were white) and the other half into thick-pig sand-moulds (heated and protected so that the pigs were very grey); thus would be available two lots of pig-iron differing only in the fact that one contained little or no graphite, whilst the other contained much and large graphite. Standard castings made by melting these irons separately in a cupola worked under standard conditions would provide some highly interesting information—even the rates at which the two irons melted and their tapping temperatures might prove instructive, whilst test-pieces would show any differences in grain, graphite and pearlite sizes, net-work structure and physical properties. Much research work upon cast iron is rendered obscure because the workers allow many variables whilst studying but one of them; here, however, is a plain proposition, the answer to which would be valuable to everyone. I am, yours, etc.,

Horace J. Young.

3, Central Buildings, Westminster,
London, S.W.1.
December 20, 1928.

Cost of Alloy Additions in Cast Iron.

To the Editor of The Foundry Trade Journal.

Sir,—I have read, with considerable interest, Mr. H. J. Young's Paper referring to high-class cast iron, which was reproduced in your issue of December 6. In this article Mr. Young makes a reference to the cost of alloy additions in cast iron, and states that an extra 40s. per ton would be required to make up a cast iron containing either 0.25 per cent. of titanium, 0.5 per cent. of chromium, or 1 per cent. of nickel. In my experience, however, 40s. a ton would adequately cover the cost of making the combined nickel and chromium addition, in fact, 35s. is usually considered sufficient for this. Actually 30s. a ton is the allowance necessary for making the nickel addition alone.—Yours, etc.,

Arthur B. Everest.

59a, Abbey Road, N.W.8.

Steel Sleepers.

One could read into "Marksman's" remarks anent steel sleepers, that these were castings, as he stated that the chair portion was "cast" integrally; what he should have said was "fabricated" integrally.

Random Shots.

It is a fact not infrequently remarked upon that although the young technical men in our midst come from all sorts of training colleges and universities, they very rarely come from Oxford or Cambridge. Tradition, of course, dies hard, and none more so than the tradition of classical learning at the older universities. Moreover, the newer civic centres have sprung up mainly in active and industrial parts of the country, where local needs and local topics point emphatically in the direction of modern studies — that is, scientific studies both pure and applied.

* * *

To my mind this is anything but a desirable state of affairs. It tends to make a sharp division between the traditional and the progressive, which can only be to the detriment of both. I am always glad, therefore, to note any tendencies in the other direction. Such was the proposal, recently announced, to increase the emoluments of the Cambridge Readership in Metallurgy by £500 per annum when a new appointment is made. Cambridge has a wonderful name in the world of science, but her engineering is little and her metallurgy less, and it is these branches of scientific study that interest us in the metal industries.

* * *

Another direction in which the steel industry is looking for salvation is the use of steel pit props in mines. It is not generally understood that mine casualities and fatalities are due in the main not to gases, explosions and so on, but to falls of roof, especially near the coal face. The timber prop is easily cut to length, easily transported and takes compression fairly well. The great feature of a prop is that it must be adjustable in height, and a really good prop would allow a roof fall of several inches before it required replacing. Then the replacement must be easy.

* * *

It will be seen that the problem of getting a rigid prop under load which is capable of being quickly reduced to pieces for dismantling is not easy. Yet the miles of workings in our mines would create an enormous demand. A prop made by removing part of the web of an H girder and then bending over the flanges at right-angles to form a top and bottom was used thirty or forty years ago.

* * *

The Dialogues of Albert, the Foundry Foreman.

II.

Albert and the Worthy Person.

The W. P.: I understand that you are in control of a considerable group of men?

Albert: That's so, and it ain't easy, I can tell you.

The W. P.: I'm sure it isn't. You look quite weighed down by it.

Albert: Eh?

The W. P.: But think what a noble work it is your power to do.

Albert: I don't know as it's strike me to call it noble, exactly.

The W.P.: Ah, but it is! They look upon you as their model in all things!

Albert: Well, I 'adn't 'ardly realised it.

The W. P.: Just think in how many ways you can set them a lasting example—by your temperance, your language, your discountenance of all such evils as betting and gambling . . . your position is indeed a responsible one.

Albert: 'Ave you ever bin inside a foundry, ma'am? Well, I don't advise you to try at your age. Illusions is best kept.

"Marksman."

The Port Talbot Steel Company, Limited, the British Steel Corporation, Limited, the Cornelly Quarry Company, Limited, the Black Mountain Silica Company, Limited, the South Wales Concrete Brick Company, Limited, and the Eagle Tinplate Company, Limited, are being wound up voluntarily. Mr. J. B. Nielsen, 5, Walbrook, London, E.C., is the liquidator in each case.

Metallurgy of Steel Castings.*

By A. McCance, D.Sc.

The subject to be dealt with is a metallurgical one, and is mainly concerned with those physical properties of steel with which the steel founder has to deal in the practice of his art: that is, physical laws governing those happenings which result in some steel castings not showing on the outside what they really are like in the inside. Thus it reduces itself down from that point of view to quite a simple matter, since the main causes of the difficulties in the manufacture of steel castings are concerned with problems of contraction. The subject lends itself to division into three sections. In the first case we have what is termed the liquid contraction: that is, the contraction of the molten metal in the mould down until it reaches its freezing temperature. In the second case there is the freezing contraction, which is the contraction which takes place when the metal passes from the liquid to the solid condition; and finally, in the last stage, there is the cooling contraction, which is that contraction which takes place during the cooling down of the casting from the solid condition at a high temperature to its condition at ordinary temperatures.

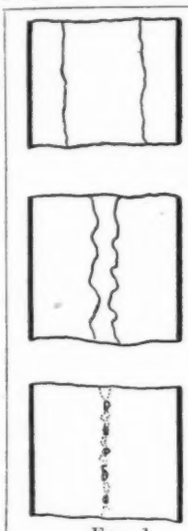


FIG. 1.

FIG. 2.

Liquid Contraction.

All liquids expand when they are heated, and it is necessary to superheat the steel a certain degree above its melting point or freezing point in order to run the casting, the degree of superheat above the melting point determining the amount of contraction naturally which will take place in the liquid condition. Here, however, steel, as in many other respects, suffers always from disadvantages, because the liquid contraction of steel is rather high. In the case of ordinary mild steel the figure is 0.00039 per deg. C., whereas for cast iron it is only 0.00019 per deg. C. This, of course, proves that steel is much more sensitive to temperature differences than cast iron is, and gives rise correspondingly to greater difficulties. In practical work it may be taken, so far as liquid contraction is concerned, that the colder the steel is run then the less contraction is obtained, always bearing in mind that it is necessary to raise the temperature above its freezing point in order to run the casting.

Solidifying or Freezing Contraction.

Pure iron in passing from the liquid condition at its melting point to the solid condition immediately beneath that, contracts by an amount which is roughly about 5¼ per cent. In the case of cast iron the figure is only 3.6 per cent.; but in the case of cast iron there are the modifying expansions which take place later which counteract very largely the effect of this contraction. In steel there is no such alleviating circumstance, and the art of the founder is so to adapt his processes to take charge of this contraction. This contraction can be seen very clearly in the case of the steel ingot, and Fig. 1 shows the section of a rectangular ingot that has been sectioned down the centre, from which it will be seen that solidification takes place from the outside in parallel sheets. Fig. 2 is a diagrammatic representation of what is taking place. On the outside there is the mould surface, and the steel solidifies approximately parallel to it. If it solidified exactly parallel many of our troubles would disappear, but unfortunately it solidifies with an irregular surface, and they finally touch at various points and ultimately leave little contraction cavities which are left to take care of themselves. In the manufacture of steel castings, therefore, this contraction has to be taken care of, and the method of doing that is by fixing a head on the portions where the contraction is likely to take place. These heads, remaining liquid for a longer period than the main body of the casting, allow the liquid metal in them to drain down into the casting underneath. It will be seen, therefore, that any change in section which may take place in a steel casting is likely to give rise to such a contraction cavity. For instance, if a roll section were cast on end it is obvious that the neck and wobbler part would solidify much quicker than the central body, and so all the contraction which takes place would be left as a cavity in the centre of the roll.

It is sometimes supposed that to take care of this contraction all you have to do is to put a head on the top, but unfortunately that is not borne out in practice. For any size of head there is a definite depth of metal only that can be fed by that head, and if that depth is exceeded then it gives rise to unsoundness down the centre. In the case of an ingot such as is shown in Fig. 3, the last portion to solidify is the metal which is moving down from the molten metal,

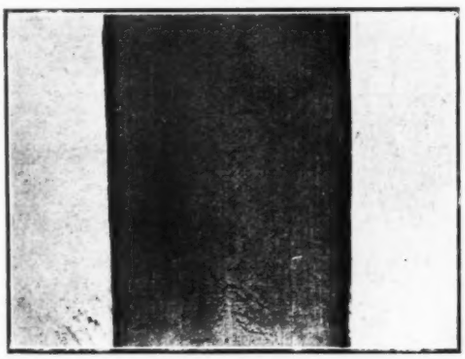


FIG. 3.

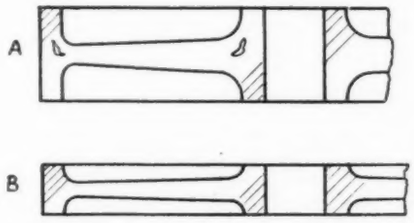


FIG. 5.

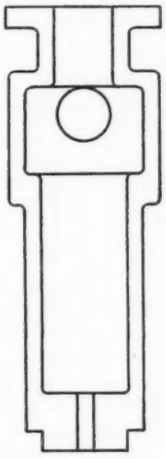


FIG. 6.

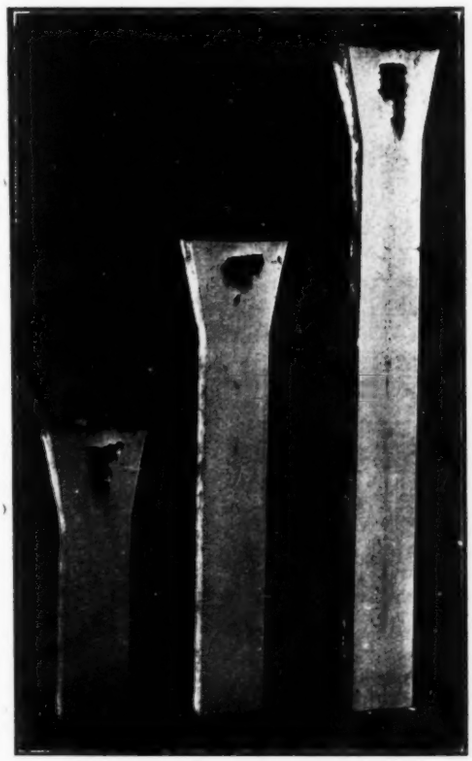


FIG. 4.

* A contribution to a symposium on related subjects organised by the Scottish Branches of the Institute of British Foundrymen and the Institution of Mechanical Engineers.

leaving sundry other minor contraction cavities, generally at a V angle to the centre line. Fig. 4 shows three small ingots which the author prepared to illustrate still more clearly this factor. In this case the small ingots were cast in sand, and they were all run from the same charge and at the same time, and it will be noted that the size of head on the smallest body is sufficient to make the ingot completely sound. The same size of head on a slightly larger ingot has left one or two cavities down the centre, and on the still longer ingot it will be seen that there is a considerable area of unsoundness right down the centre, so that there is a definite size of body that can be fed from any definite size of head. This question is of great importance in matters of design, because in the case, say, of two gear wheels with different breadths of rim, one like Fig. 5, which is of comparatively small depth, can be fed without any difficulty, and will result in a completely sound casting, whereas a design with greater depth is too great in this dimension in the normal way to feed, with the result that there is a cavity left at the junction of the last portion which solidified. Some designs are particularly bad in that respect (Fig. 6). A casting of such design is difficult to get completely sound, and the only method by which a steel founder could assure soundness would be to get it redesigned.

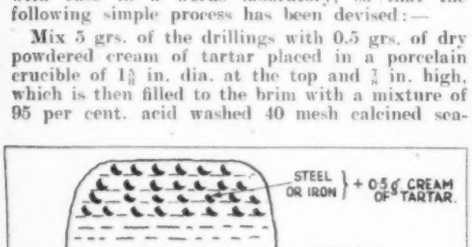
(To be continued.)

A Note on the Estimation of Sulphur in Steels and Cast Iron.

By N. D. Ridsdale.

The organisers of the British Chemical Standards Movement have pointed out for some time that all carbon steels and cast iron in the form of millings, drillings, etc., after being in contact with air for a considerable period—usually at least two years—even when stored in a sealed container, and whilst still remaining bright, cease to yield the full quantity of sulphur as sulphide when dissolved in hydrochloric acid. The result in such a case is that the standard value for sulphur as determined by the evolution process shows low and to oxygen-free atmospheres, such as carbon dioxide or nitrogen, before making the determination. This is not ordinarily carried out with ease in a works laboratory, so that the following simple process has been devised:—

Mix 5 grs. of the drillings with 0.5 grs. of dry powdered cream of tartar placed in a porcelain crucible of $1\frac{5}{8}$ in. dia. at the top and $\frac{7}{8}$ in. high, which is then filled to the brim with a mixture of 95 per cent. acid washed 40 mesh calcined sea-



sand and 5 per cent. powdered cream of tartar. Place on it a silica capsule $1\frac{1}{4}$ in. internal dia. and $\frac{1}{2}$ in. deep. Invert and fill in the space on the outside between the crucible and the capsule with the sand-tartar mixture, as shown in the sketch.

Insert gradually into a muffle at 750 to 850 deg. C.—not hotter, or the glaze will be badly attacked—and when pushed right in, heat for 20 mins.; take out, cool on an iron plate, then put entire contents into a sulphur flask and evolve sulphur as usual with hot strong (D 1.16) HCl.

A blank should be used on the reagents to be sure that they do not yield any sulphur as sulphide when treated according to the test. Cream of tartar is usually free, but sand, even after washing, has been found to contain a little sulphur, which will be reduced to sulphide and which must be allowed for.

At headquarters, after carefully making a number of tests on different standards, the accuracy of the process has been established. White iron and certain alloy steels which do not yield all their sulphur as sulphide by direct evolution, may also be treated successfully by this method.

As further confirmation of the application of the method for white iron it has been submitted to two different chemists experienced in the analysis of these irons; namely, Mr. R. D. Dick, of Messrs. Peace & Partners, Limited, Normanby Iron Works, Middlesbrough, and Mr. A. E. Peace, of Messrs. Leys Malleable Castings, Limited, Derby, and in each case several tests on white irons have been in close agreement with the gravimetric method, whilst the ordinary evolution process without annealing has given low results.

Annealing with cream of tartar, etc., has, of course, been recommended for years, but the methods of carrying it out have not been satisfactory on account of the uncertainty of ensuring complete freedom from oxidation. The only new feature about this method is the simple and sure means employed to avoid oxidation.

Vickers—Vickers-Armstrongs—Cammell Laird Steel Fusion.

Details of the Proposals.

Announcement was made in our last issue that negotiations were proceeding for a working arrangement between Messrs. Vickers-Armstrongs, Limited, and Messrs. Cammell Laird & Company, Limited. We are now able to give details of the arrangement.

Subject to certain consents which have yet to be obtained, two agreements have been concluded between Messrs. Vickers, Limited, Messrs. Vickers-Armstrongs, Limited, and Messrs. Cammell Laird & Company, Limited. The first agreement, to which all three firms are parties, provides for the amalgamation of the whole of their steel interests with the exception of those concerned with guns, gun mountings and armoured cars and tanks. A new company, to be called the English Steel Corporation, Limited, will be formed for the purpose of taking over these steel interests, which are as follow:—

From Vickers-Armstrongs:—River Don Works, Sheffield (with the exception of certain gun-making plant and plant for armoured cars and tanks); Attercliffe Works, Sheffield; Holme Lane Works, Sheffield; Openshaw Works, Manchester (with the exception of the gun-mounting plant); the plant for drop forgings at Elswick.

From Vickers, Limited:—The ordinary shares in Taylor Bros. & Company, Limited, steel tyre, axle and wheel manufacturers, of Trafford Park, Manchester.

From Cammell Laird & Company, Limited:—Cyclops Steel & Iron Works, Sheffield; Grimesthorpe Works, Sheffield; Yorkshire Steel & Iron Works, Penistone.

Negotiations are also in progress for including in the new company other important firms in the steel industry.

Merging of Wagon Interests.

The second agreement, to which Vickers, Limited, and Cammell Laird & Company, Limited, are parties, provides for the amalgamation of all the railway carriage and wagon interests of the two companies. For this purpose, the name of the Metropolitan Carriage, Wagon & Finance Company, Limited, which is a subsidiary of Vickers, Limited, will be changed to the Metropolitan-Cammell Carriage, Wagon & Finance Company, Limited, and the carriage and wagon interests of Messrs. Cammell Laird will be transferred to it. The Metropolitan-Cammell Carriage, Wagon & Finance Company, Limited, will therefore comprise the following:—

From Vickers, Limited:—Metropolitan Carriage, Wagon & Finance Company, Limited; Patent Shaft & Axletree Company, Limited; Willingsworth Iron Company, Limited.

From Cammell Laird & Company, Limited: The Nottingham factory; their interest (which includes practically the whole of the issued ordinary shares) in the Midland Railway Carriage & Wagon Company, Limited, and in the Leeds Forge Company, Limited.

It should be noted that these agreements cover only the steel and railway carriage and wagon interests of Messrs. Vickers, Limited, Vickers-Armstrongs, Limited, and Cammell Laird & Company, Limited, and that their other activities are unaffected and will be carried on as heretofore.

American and European Iron and Steel Conditions.

At a meeting of the American Iron and Steel Institute, held in New York on October 26, Mr. C. A. Meissner read a Paper on "Recent Observations on Some European Iron and Steel Conditions," in the course of which he remarked that one especially noteworthy difference between European and American open-hearth practice was the wide use of blast-furnace gas in conjunction with by-product coke-oven gas, particularly in Germany. As a rule, the combination was one part by-product to two parts blast-furnace gas, the amount of by-product gas being varied according to the heat requirements of the furnace during various stages. German by-product gas, as a rule, was approximately 450 B.T.U. per cub. ft., blast-furnace gas being 106 to 112 B.T.U. per cub. ft. It was claimed that preheating both gases in gas chequers was considered an advantage, in that the dissociation of the gas and heating in the chambers made this gas more valuable chemically through the endothermic reactions. It was said that such a gas left the chambers not only hotter, but also richer.

At some plants (continued the speaker) the mixture of blast-furnace, producer and coke-oven gas is used. The use of large amounts of blast-furnace gas in the manner described has proved to be an economical procedure in Europe. While certain experiments have been performed in the United States in the use of blast-furnace gas, they have not progressed sufficiently far to give any definite results. At the present time, however, it is understood that one plant at least is seriously considering the use of blast-furnace gas in conjunction with by-product gas for open-hearth melting purposes.

An intensive study of fuels and heat balances has been made in Europe, particularly Germany, and it appears that more attention has been given this phase of open-hearth operation than is generally observed in the United States. However, actual results obtaining in fuel consumption there compare very favourably with results obtained at the best European plants. There is a somewhat greater tendency to use tilting furnaces in Europe than in America, due to some extent to the use of higher-phosphorus materials and the ability to more carefully regulate slag conditions. Such furnaces appear to answer their needs to somewhat greater advantage than the stationary type widely used in the United States. The percentage of pig-iron and analyses of materials used there are important factors.

Water-cooling of furnaces is not as widely practised on the Continent as in America, though the more recently constructed units have made provisions for cooling. The newer units more closely approach American standard practice, the buildings being of the heavy type, with ample provision for stocking and charging, and roomy pits and pouring platforms.

An outstanding feature in Europe is the strong tendency to Americanise the plants, especially the blast-furnace plants, by following American blast-furnace lines and in some cases the methods of construction. In the coke-oven plants there exist a number of modern American-type ovens, all built with the idea of utilising all of the rich gas in the steel mills or for public service, and heating the ovens with either blast-furnace or producer gas.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for October, report that the production of pig-iron in that month amounted to 543,600 tons compared with 503,900 in September and 596,300 tons in October, 1927, the daily rate of production in October being 17,536 tons against 16,797 tons last September. The number of furnaces in blast increased by five during the month to 136. Steel production in October amounted to 756,000 tons, an increase of 37,400 tons compared with September.

Electric Furnace Developments.*

By D. F. Campbell, M.A., A.R.S.M.

Before describing modern developments in electric-furnace practice it may be of interest to mention a little of the early history of this important branch of metallurgy and outline some idea of the heavy electro-metallurgical industry and what it involves.

The large electro-metallurgical works were all situated in districts where water power was available, but recently it has been found possible to use electricity produced from cheap fuel, such as the brown coal of Westphalia.

Smelting of aluminium metal from pure alumina refined from bauxite, the manufacture of ferro-alloys and calcium carbide, and the production of synthetic nitrogen compounds, are the most important consumers of powers in electro-metallurgical works, and the power stations which are used for these purposes usually vary from 20,000 to 100,000 h.p.

Tendencies in Cost of Current.

There is tendency now to remove these factories to more inaccessible water-powers, as the market for electricity for motive-power is increasing so rapidly that these industries cannot afford to pay the price offered for mechanical power in the more populated districts. On the other hand, interconnection of numerous power stations may result in large blocks of surplus power becoming available at low cost, which may result in the establishment of certain electro-metallurgical industries, where power is generated from fuel, if operation of the works can be arranged to be adjusted to take advantage of off peak loads.

The first melting furnaces were used commercially in about 1900, and the melting of steel engaged the attention of Héroult after he had perfected his aluminium and ferro-alloy smelting furnaces. He was a great pioneer in electro-metallurgy, and a man of great foresight and courage.

He despised experimenting with electric melting furnaces on a small scale, and he invariably used not less than 100 kw. for the smallest experiments. One of the earliest furnaces was constructed in collaboration with the author in California for the smelting of iron ore, and the features of this installation were somewhat typical of Héroult and his way of working. This furnace, built in an inaccessible place in the wilds of N. California, was of 2,000-kw. capacity, and the power supply to the transformers was 33,000 volts. At that time electrical knowledge was much less than that of the present day. The highest voltage in transmission lines was only 30,000 to 50,000 volts, and knowledge of eddy currents very limited. This type of furnace has now been developed to sizes of 8,000 to 10,000 kw.

Stages in Development.

Historically, the development of electric furnaces passed through three stages. Laboratory experiments of Siemens and Ferranti demonstrated the principles of heating by the arc and by induction. Moissan, in France, published his remarkable metallurgical researches, which were based on the new facilities to work at high temperatures in controlled atmospheres, which were only possible by the use of his new electric furnace.

The commercial development followed. Héroult first discovered the modern method of making aluminium, which gave a new metal to industry at a reasonable price. He then developed his arc furnace for carbide, ferro-alloys and steel, and at the same time Stassano was working with the indirect arc, and Kjellin with the induction furnace. For fifteen years these furnaces were used for steel and metals of high melting point, and it was only after 1914 that the induction furnace was generally adopted by the non-ferrous trades, and in the last three or four years the high-frequency furnace has become available.

* A Paper presented to the Joint Co-ordinating Committee of Birmingham.

From the romantic beginnings twenty years ago one can now consider with interest the present scope of electric melting and heat treatment, and the less romantic little furnaces for the non-ferrous trade. It is proposed to describe the various melting and heat-treatment operations to which electricity has been applied, and some of the factors which have to be considered when deciding whether to use electricity or not.

Brass-Melting Furnaces.

In the case of brass melting for casting strip for rolling-mill work, and billets for extrusion presses, there is no doubt that induction furnaces should be used wherever the production of brasses of different quantities is sufficient to keep a furnace operating 12 hours per day. The minimum output for a normal 60-kw. furnace working 60 hours per week would be 15 to 16 tons per week, and a similar furnace working for 120 hours should produce 30 to 34 tons. The output depends largely upon the casting methods used. In some works 12 minutes or more may be occupied in casting and feeding a number of small strip moulds, while a whole furnace may be teemed into a single water-cooled mould in one minute. Thus a difference of 10 minutes per cast may make a difference in production of nearly ¾ ton per day. This type of furnace is very economical in power consumption, and has been generally adopted throughout the world as standard equipment for rolling-mill and extrusion brass. The value of this furnace has recently been proved by several years' successful operation on nickel silvers and phosphor bronzes of various composition, but in the latter case linings of special composition and manufacture are essential for a long life. This furnace, however, is now the most economical method of melting nickel silver.

The following figures of the cost of manufacturing nickel silver by the coke and electric furnace respectively are submitted for discussion:—

Coke Furnaces.

	£	s.	d.
Labour	1	17	0
Coke at 30s. per ton ...	0	13	0
Pots and linings	0	7	6
	2	17	6

Electric Furnaces.

	£	s.	d.
Labour	0	16	6
Power	0	18	9
Lining	0	4	0
	1	19	3

These figures show a saving of 18s. 3d. in favour of electric melting. Unfortunately, there are only a limited number of firms who have sufficient output to keep an electric furnace operating fairly regularly, and consequently the necessary capital expenditure is an obstacle in the case of works where output is small and production intermittent.

Melting Nickel and Its Alloys.

The melting of nickel, and alloys containing over 33 per cent. nickel, should be carried out in a high-frequency electric furnace, and great improvements in the rolling and drawing qualities of these metals have been effected since this method of melting was introduced. The best metal is made in furnaces having linings free from plumbago, and the new patented form of fritted lining is giving a long life and metal of exceptionally high quality. The normal life of such a furnace lining is 180 to 250 heats, when melting alloys containing 50 to 80 per cent. of nickel, and thus the cost of linings is reduced to less than 2s. per ton, as compared with a crucible cost of many shillings per ton. It would be interesting to learn the opinion of metallurgists as to the reason why plumbago crucibles in electric furnaces give unsatisfactory metal. The author has his ideas on the subject, but has not yet carried out the necessary work to prove his hypothesis.

The melting of copper is being carried out in electric furnaces, and a great improvement in drawing qualities results. Furnaces of granular carbon resister type in which the heat is reflected from the roof are used for this purpose and also high-frequency furnaces. These are advantageous for the melting of scrap and refining operations, but it is not likely that the electric furnace will replace the large reverberatory furnaces used for the refining of virgin copper.

The arc furnace, which finds such wide application in the steel trade, is but little used for non-ferrous metals, though a few arc furnaces are in use for melting rich nickel alloys, and the indirect arc is largely used in the U.S.A. in rocking furnaces for melting bronzes and in the brass foundries. In the former case high-frequency furnaces are tending to replace arc furnaces. In this country the majority of brass foundries are either small establishments, where the capital expenditure for electric equipment is a serious item, or else the foundries work intermittently and require very large castings. This is especially the case in ship yards, where it is not considered economically possible to erect the large electric furnaces necessary for such castings as large propellers, because the capital expenditure is very high, and the work would be very intermittent. Furthermore, in the case of bronze the advantages of electric melting are comparatively few.

Heat Treatment Furnaces.

Having described briefly the present position of electric melting furnaces, the author proceeded to show a few installations of furnaces for this purpose. A wider field of usefulness for electric heating is found in the heat-treatment of metals, but this has not been so widely-developed as melting, though it affords equal opportunities for the useful application of electricity. The advantage, however, will be more in improvement in quality, giving an indirect saving in cost of manufacture, but unfortunately this is not so attractive or easy to demonstrate as the definite reduction in prime cost and improvement of quality, which can be easily established with many electric-furnace melting problems.

In considering heat-treatment furnaces, the designer must balance many considerations. The cost of power and the schedule of working will determine the amount that should be spent on insulation. There is an optimum lagging for any cycle of operations, and these must be considered by the designer and purchaser when considering offers of furnaces, as insulation is a serious item in the cost of this equipment. The cost of a simple highly-efficient box-type annealing furnace is made up: (1) steelwork body and door mechanism, 29; (2) insulating and firebrick work, 18; (3) nickel chrome castings, 9; (4) nickel chrome wire, 4; (5) electric instruments, switches, etc., 10; (6) heat control instruments, 14; and (7) erection, 16 per cent. From these figures the high cost of insulating material and the low cost of nickel-chrome wire and electrical instruments is striking, and this probably accounts for the fact that in the United States most large furnaces are built by furnace specialists and not by electrical equipment manufacturers. In this country many types of resistance furnaces are in operation in addition to the single box-type of furnace used in tool rooms and for simple heat-treatment and carburising purposes. It is impossible to develop any furnace suitable for all purposes, and for almost every metallurgical operation special equipment must be designed.

There are certain characteristics of electric furnaces as compared with gas- or coal-fired equipment, and these are cleanliness, accuracy of temperature control, and freedom from noxious gases. Temperature-control is especially easy, because the source of heat is so little different from the working temperature, whereas flame temperatures are invariably high. Furthermore, there is no volume of gas or products of combustion passing through or near the working-hearth. The heat is especially easy to control when accurate low

temperatures are required for the heat-treatment of aluminium alloys at 525 deg. C., for example. With electricity, however, the heat unit is expensive, and it must be applied with due consideration of this fact. Consequently, all boxes and conveyor parts must be reduced to a minimum weight, and the wasteful heat-losses, which are characteristic of many fuel-fired furnaces, cannot be tolerated if electric heating is to be economically possible. Therefore, a great improvement in design of these furnaces has been made, and the attention now being paid by gas-furnace engineers to the methods adopted to justify the use of electric heat. In considering the use of electricity, a few fundamental figures should be considered. If a unit of electricity costs ½d., and town gas costs 2s. per 1,000 cub. ft., the electrical unit of heat is about three times more expensive than gas, and its use is only justified when it can be more economically applied, or where gas is objectionable for other reasons.

First, improvements have been made in heat-economy by a very careful study of insulation, both as regards metal structures and brickwork, and the elimination of heat-losses by careful design of doors. Secondly, furnaces of the rotating-hearth type are largely used for small parts. Thirdly, recuperation by heat exchange in intercommunicating heating and cooling chambers is practised to a considerable extent with satisfactory results, and, lastly, double-way working, sometimes called the contraflow principle, is used in tunnel-kilns, and has been suggested for continuous strip and wire annealing. In addition to the above general principles, water-sealed furnaces have been used for bright-annealing, and furnaces arranged for working in atmospheres of special gas employed either for treating wire continuously, or boxes of stampings, coinage blanks, etc.

The methods of heating successfully applied are nickel chrome resistors in the form of wire-strip or cast-grids for temperatures below 1,000 deg. C., and resistors of glazed-graphite or complex mixtures of silicon-carbide with silicon and other ingredients for temperatures above 1,000 deg. C.

Strip Annealing Furnaces.

It is often necessary, when applying electric heat, to modify radically the method of annealing or heat-treatment, and thus it is probable that the continuous strip-annealing furnaces will be applied generally to brass instead of endeavouring to build box-type furnaces to follow the old custom of annealing in coils. A number of these continuous strip furnaces are giving complete satisfaction in Continental brass works, and it seems that Birmingham manufacturers would be wise to consider if they wish to produce better strip, and are prepared to pay a little more for the annealing process, in consideration of savings in subsequent operations, and improvement in quality.

Tube Annealing.

Probably the most efficient heat-treatment process is the Snead tube-annealing machine, which, however, is only applicable to rods or tubes. With this apparatus the heating period for a tube is only 3 to 4 seconds, and the power-consumption less than 50 units per ton for normalising brass tubes, but the apparatus has certain limitations to its application.

This machine consists of a bench about 25 ft. long on which are mounted two clamps or jaws for holding the tubes. Pressure is brought on to these by two solenoids, and they are shaped to fit the tube. They are composed of a metal of suitable conductivity and heat-resisting properties. One clamp is fixed at a point on the bench convenient for the length of tube to be treated, and the other is on a carriage equipped with wheels on ball bearings. Each clamp is connected to one terminal of a transformer, giving a current of about 6,000 amps. at 20 to 50 volts. This transformer is controlled by a contactor switch which may be operated by hand, or automatically from the control dial. To operate the machine, a girl rolls a tube into position on the jaws and depresses a pedal. This makes the solenoids close the jaws and the heavy current passes through the tube as the contactor switch is automatically closed immediately after the jaws are firmly holding the tube. As this heats, it expands, and the carriage is pushed forward by the expansion of the metal. The extent of this movement gives a definitely correct thermometric determination of the temperature of the tube. The dial indicates the extent of this movement, and an adjustable finger makes contact with the pointer when the desired temperature is reached, the main contactor switch is automatically tripped, the solenoids automatically loose the tube, which is rolled down a slope to the bench below. The whole operation is completed in 4 secs., and, in certain American works, the next tube is ready within 4 secs., so the complete round of work is said only to occupy 8 secs. This exceptional rapidity accounts for the low energy consumption, for all heat losses are a function of time, which in this case is reduced to a minimum. In a European works an average working hour produces 200 annealed tubes, at a cost of 45 kw.-hrs. per ton.

Other Types of Furnaces.

Another method of annealing brass tubes, which is being successfully applied on the Continent, is that of a side charged electric annealing furnace. A typical installation consists of a furnace of 240 kw. capable of annealing one ton per hour at 600 deg. C. at an expenditure of 127 units per ton. This furnace is 7 metres in length, and has a flat roof. It is heated in floor and roof, and equipped with electrically operated, specially designed quick-acting doors and charging machine. Another simple form of furnace of 160 kw. capacity is used for annealing brass sheets from 2.5 to 5 mm. thick in bundles. In such a furnace, working at 600 to 660 deg. C., the power consumption is 120 kw.-hrs. per ton, but in this case there are no recuperative features.

A similar furnace used for heating brass billets requires 120 kw. and a power consumption of 120 kw.-hrs. per ton, but this cannot generally be recommended as an operation for electric heating, unless there are advantages to compensate the extra cost of heating as compared with gas.

A Three-Chamber Furnace for Aluminium.

Another example of annealing non-ferrous metal is the three-chamber furnace, in which one chamber is used for heating, and two are used for heat recuperation and exchange. The furnace shown is of 100 kw. capacity, and consists of a heating chamber 15 ft. in length, capable of heating a 25-cwt. charge of aluminium. Accuracy of temperature control is of fundamental importance in the heat treatment of aluminium and its alloys, and this furnace combines a high degree of efficiency with accurate temperature control. When operating this furnace the bogie top with the hot charge is put in a heat-transfer chamber with the cold charge, and about one-third of the sensible heat is recuperated in this way. It is important that all bogies and charging mechanism shall be especially designed for electric furnaces, as the heavy and wasteful bogies which are tolerated in most fire-heated furnaces would be inadmissible in electric-furnace practice.

In addition to accuracy of heat control, low labour costs, smaller space for equal output, low maintenance cost, and the reduction or elimination of annealing boxes are features of this type of equipment.

Another furnace used for the heat treatment of aluminium alloys is a pair of box-type furnaces, each rated at 55 kw. when used for this work at low temperature, or 120 kw. if used for high-temperature heat treatment or carburising operations. The reduction in rejected parts is a striking feature when comparing this furnace with similar fuel-fired furnaces. A further advantage lies in the possibility of switching on the furnace at any time, before the day shift commences work, by automatic time switches. Thus the furnace can be heated to working temperature by the time the men come to work. Rotating hearth furnaces may also be used for the heat treatment of small parts.

Continuous Annealing.

An interesting system of continuous annealing of wire and strip has been attempted by heating wire by resistance, the current being passed through the wire. This, however, has not found general application, owing to difficulties of passing the current from the rollers to the wire without overheating and damaging the wire. Inequalities in the conductivity of the wire may also produce uneven heating and irregular results.

Water-sealed furnaces are used for the bright annealing of copper wire, and these consist of vertical cylinders heated by resistors. The bottom is closed by a water seal, through which the furnace is charged. The advantages of electric heating in this case are not so marked, as coils of copper wire can be satisfactorily annealed in machines of the Bates-Peard type. The continuous annealing of special wires is carried out on a large scale, where special atmospheres are required and a high quality of product is made.

Resistance Furnaces.

A large battery of furnaces, each consisting of a unit of 45 kw. capacity, 12 ft. in length, heated by cast nickel-chrome resistors, has been in operation for several years in London. The cross-section of the chamber is small and contains 8 to 10 nickel-chrome alloy tubes, having an internal dia. of ⅝ in. A neutral atmosphere is maintained in these, and the complex wire is wound continuously through the tube and can be annealed at any required temperature between 650 and 850 deg. C. by automatic control in an atmosphere free from air. Furthermore, this furnace can be divided into two zones giving different heat treatment in each.

This annealing of brass strip has been effected experimentally by heating coils by induction. This method has been found less advantageous than resistance furnaces for continuous strip annealing. This may be carried out either in a sloping or horizontal furnace, but the latter is quite satisfactory, and less complicated. The strip is allowed to pass in a loose catenary form through the furnace, and the tension is so regulated that all stretching is avoided. The resulting brass strip has a very fine finish and subsequent cleaning operations are reduced to a minimum.

The above particulars relate to furnaces for melting metals or heat-treatment operations at temperatures below 1,000 deg. C. Sometimes furnaces are required to operate at higher temperatures, such as 1,100 deg. to 1,200 deg. C., and at present no metals are available which are suitable for resistors capable of giving these furnace temperatures, though it is to be hoped that suitable alloys will be made in the future. For these high temperatures, resistors of graphite, or silicon carbide impregnated with silicon, must be used.

Another method of building high temperature furnaces is by the use of resistor rods made of carborundum and silicon mixture. These furnaces should be provided with auto-transformers, as the resistance of the rods varies with the time they are in use, and temperature regulation can only be achieved by this means. They have the disadvantage of fragility, but some furnaces of this type are giving good service. Very high temperatures can be obtained by induction, but the control of such furnaces for heat treatment presents some difficulties at present.

The author has endeavoured to give some idea of the present scope of electric melting and heat treatment, and he thinks it will be generally agreed that metallurgists will gradually be forced to adopt this system of heating.

Reorganisation of many works to the principle of "Straight Line" manufacturing is becoming possible, where the cleanliness of electric furnaces enables them to be used in machine shops, and the isolation of heat treatment or brazing departments is no longer necessary. The continuous annealing of strip in furnaces having no chimneys and flues, no waste gases or ashes, and no necessity for coal bunkers for storage, enables a steady stream of metal to flow through the works and avoid the check of production which is inevitable with batch annealing in fuel furnaces. Thus stocks in process are reduced and profits increased. Control, cleanliness and continuity of operation, coupled with improved labour conditions, quality and high efficiency enable the electric furnace designer to offer the works engineer a new vista in the design of modern metallurgical works.

Institute of British Foundrymen.

LONDON BRANCH ANNUAL DINNER.

The annual dinner of the London Branch of the Institute, held at the Engineers' Club, Coventry Street, W.1, on December 14, was as usual a very successful and most enjoyable function. Mr. W. B. Lake, J.P., occupied the Chair for the second year in succession as Branch-President, and the gathering included also Sir Berkeley Sheffield, Bart., M.P., Mr. S. H. Russell (President of the Institute), Captain R. B. Crewdson (Director, THE FOUNDRY TRADE JOURNAL), Dr. S. W. Smith (Chairman of the London Local Section of the Institute of Metals), Mr. Wesley Lambert (Vice-President of the Institute, and Past-President of the Branch), Mr. V. C. Faulkner (Editor, THE FOUNDRY TRADE JOURNAL, Past-President of the Institute and of the Branch), Dr. A. B. Everest, Mr. R. B. Deeley, Mr. J. W. Gardom (Vice-President of the Branch), Mr. K. W. Bridges, Mr. J. E. Hurst, Mr. J. Ellis (Past-President of the Institute), Mr. John Shaw, and Mr. H. G. Sommerfield (Hon. Secretary and Treasurer of the Branch).

The toast of "The King" was honoured with even more than the usual fervour, in view of His Majesty's illness, and in proposing the toast the Branch-President voiced the general hope that His Majesty's health would soon be completely restored.

Goodwill in Industry.

SIR BERKELEY SHEFFIELD, Bart., M.P. (who was introduced by the Branch-President as one who had achieved a reputation in politics, war and industry), proposed the toast of "The Institute of British Foundrymen." He proposed the toast, he said, with some trepidation, because he realised that his powers of eloquence were not such as would enable him to express adequately his good wishes for the Institute's success. Although the foundry industry might not be described as a basic industry, its products were essential to the well-being and comfort of the nation, and of the world. The activities of Institutes such as this must tend to alleviate to a very large extent the difficulties of the industrial situation, because the membership included both employers and employed, and he was perfectly certain that one of the greatest factors in the future success of British industry would be the good feeling existing between masters and men. The masters could not do without the men, but he assured the men that they could not do without the masters; that being so, for Heaven's sake let them be friends, working together for the prosperity of the nation. He had spent the whole of his life in the iron and steel trade, and his particular district of Frodingham and Scunthorpe, in North Lincolnshire, was responsible for the second largest output of iron and steel (both in the raw and the manufactured state) in the whole of the United Kingdom. In 1908 some little difficulty had occurred in the relations between the masters and the men, and he had been honoured by being asked to try to bring the representatives of both sides together for the purpose of discussing the matter round the table. The two sides had met and an agreement was reached, and since that time there had been no worry or trouble between them; they had had differences, but had always been able to settle them among themselves, and he hoped fervently that that example would be followed in every branch of industry in Great Britain. It was by the activities of bodies such as the I.B.F. that good fellowship and goodwill were fostered. What was better than for those engaged in the industry to meet at a festive board, to renew their friendships and to discuss their problems. Referring again to the North Lincolnshire area, he said that although some of the men had been working short time, and some of the furnaces had been damped down during the period of distress from which the industry had suffered, they had not suffered to the same extent as other districts had, and the reason for that was that all engaged in the industry in the district were friends one with another. Sir Berkeley coupled with the toast the name of Mr. S. H. Russell.

THE BRANCH-PRESIDENT, inviting Mr. Russell to respond to the toast, expressed indebtedness to him for having honoured the gathering by his presence.

The Basis of Industry.

MR. S. H. RUSSELL (President of the Institute), after expressing thanks for the manner in which the toast had been proposed and received, said that he and the members of the Institute generally had a very great respect for the London Branch, and his esteem had been enhanced as the result of his attendance at the annual dinner of the Branch. The Branch was one of the strongest in the Institute. He had been asked frequently why there was a tendency for industry in this country to move south, and in the past he had difficulty in providing a satisfactory answer; but, in view of the array of talent present that evening he would have no difficulty in providing a satisfactory answer to the question in the future. He ventured to disagree with Sir Berkeley Sheffield's suggestion that the foundry industry was hardly a basic industry. Iron was the absolute basis of our civilisation; without the marvellous—though very much taken for granted—property of magnetism in cast iron, the use of electricity would be absolutely impossible. Again, could one imagine gas being manufactured without the use of cast iron; could one imagine a steam engine working without cast iron or other cast materials being incorporated in its structure? Referring to the International Convention of Foundrymen, to be held in London in June, 1929, he said he fully appreciated the value of such conventions. He had had the pleasure of attending, with Mr. Lake and others, the second International Convention, held in Detroit, U.S.A., in 1926, and he understood that the first Convention, held in Paris, was even more popular. The industry profited enormously by the free exchange of ideas and experiences at such functions, and he welcomed particularly the opportunity which would be afforded the industry in this country next year of offering hospitality to our friends from the Dominions, from America, and from the continent of Europe. He confessed that it was a matter of great surprise to him that at the last meeting the Council of the Institute had, in its wisdom, passed a resolution, against which only one vote was recorded, to the effect that there should be no works' visits during the Convention in London in 1929. A very large number of papers was to be presented at that Convention, and the exhibition to be held would be undoubtedly a great attraction, but on behalf of the ordinary members of the Institute, many of whom, particularly in the north, are managers and foremen of foundries, he pleaded that an attractive programme should be arranged. After all, those men were the backbone of the Institute, and he doubted that the presentation of a multitude of papers would have the same appeal to them as would a number of works' visits. The conditions in the industry, he continued, were changing very rapidly. The quality and consistency of pig-iron itself was changing remarkably rapidly, and very much more metallurgical knowledge and metallurgical control was needed in order to produce a good casting than was the case even ten years ago. He had been wondering how the small jobbing foundry was going to keep its head above water in the future. Founders in some areas had adopted the practice of employing consultant metallurgists, who carried out check analyses, advised on faults, and so on, and he had been surprised to find what great assistance they had obtained thereby in return for what was really a small outlay. While there were perhaps disadvantages in the employment of consultants, there were also advantages, and, owing to this development, he believed there was still a considerable lease of life ahead of the small foundries. But it was the big foundries that must make progress, more particularly on mass production and repetition work. He had been surprised to find that the men with the real driving force behind the foundries which he had visited were not really foundrymen, *i.e.*, he doubted whether they could make moulds, and he had been very much concerned as to why that should be so. The Institute had been very much concerned recently with the problem of the examination of apprentices and the awarding of a national certificate which would have more or less universal recognition. He feared, however, that there would not be so many candidates for the award of that certificate as some people imagined.

Labour Requirements.

When he had visited Scotland he was told that what was wanted in foundrymen there was brawn and muscle. That was quite true in respect of many of the foundries there, and a large proportion of the youths in those foundries were not of the type which was capable of benefiting from the provision of facilities for education on metallurgical and scientific matters. With regard to other foundries, which were not working on the mass production principle, but were producing engineers' castings, and with regard to the jobbing foundries, who was prepared to say that even 10 per cent. of the boys employed in them would really benefit by any scheme of education such as the Institute was now considering? He did not wish to convey the impression, of course, that he opposed education; he was merely trying to point out one of the difficulties with which the industry was faced. Many reasons could be advanced to account for the present state of affairs. It was almost inevitable that the foundries equipped for dealing with the production of moulds mechanically would gradually absorb the smaller foundries, and ultimately the demand for brawn and muscle would be increased. One of the most striking features of the foundry industry in the United States was that the real donkey work was done by coloured people or by people of rather low intellectual ability, and, insofar as we should copy American practice, we should find that the operatives would tend to be of the same nature. A problem to be faced was how to improve the quality of the labour in the works at present. The successful foundryman of to-day must have a far better knowledge of industry than the foundryman of the past; he had to balance the claims of the pure scientist, the metallurgist, the equipment people, and his selling organisation. It would be agreed that the easiest way for a foundryman to acquire the necessary knowledge to-day was to become a member of the Institute. The freedom with which knowledge and ideas were exchanged to-day was amazing, and something of a revelation. He could assure Sir Berkeley Sheffield that in the Institute of British Foundrymen there were not many secrets left. In this connection he mentioned the change which had been effected in the policy of those responsible for carrying on a large malleable foundry in his district. For many years the foundry had been very jealously guarded, but later those connected with it had joined the Institute gradually, and he believed 27 of them had become members; as a result, the works had been thrown open to the members of the Institute during the last two or three years, and the members had had full facilities for inspecting the whole production of malleable iron from beginning to end. That was a definite advance which could be credited entirely to the activities of the Institute. The success of the Institute depended to a large extent upon the degree to which individual members were prepared to give their ideas and experiences in papers or in the discussions which were based on papers, but an even more valuable activity was the organisation of visits to foundries, so that members could inspect the application of methods which might be new to them. A foundry foreman could not travel to the same extent as the executive officers, and was liable to think that his methods were the only methods to be applied. If, therefore, he were given opportunities to see the

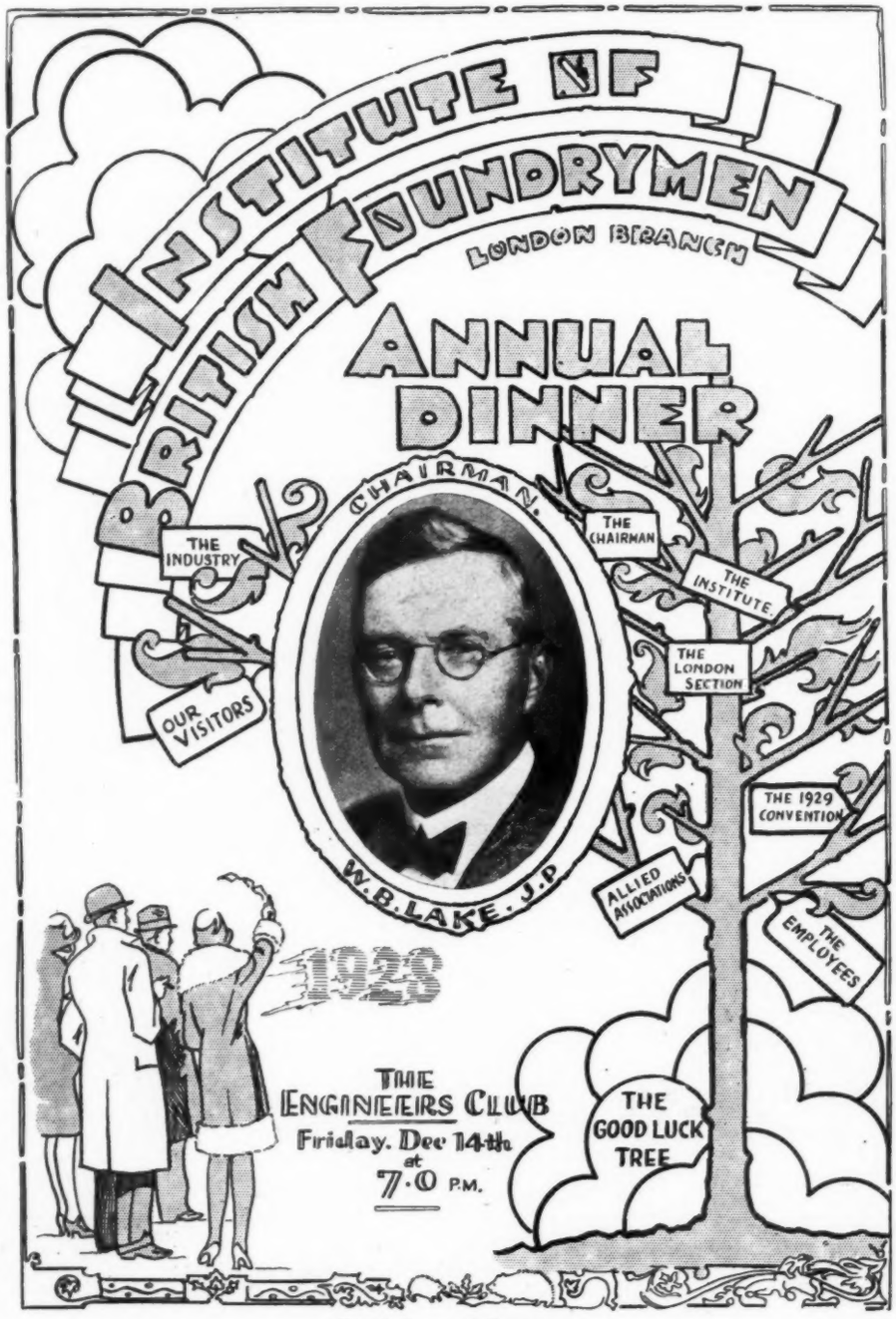
application of other methods both he and his employers would benefit.

Allied Activities.

Mr. J. W. Gardom (Vice-President of the London Branch) proposing the toast of "Kindred Associations," said that the Institute of British Foundrymen could perhaps claim to cover a wider field, in respect of its membership, than most other bodies. Its membership comprised men working on the foundry floor, the laboratory, the office, the executives, and included even salesmen; it was almost impossible for any one body to cover such a wide field adequately, and the members of the Institute, therefore, were extremely grateful to the kindred Associations for the information contained in the Papers they published, covering practice, theory, organisation and commerce. The foundry worker was second to none, but to secure for him a fair wage out of the prices obtainable at present from the severe and almost inhuman buyers of castings was a difficult matter. Great skill and science must be applied in reducing material costs, eliminating scrap, etc., and in obtaining profitable markets. Unfortunately, many works were unable to employ technical staffs such as they would like to employ to deal with the many problems which had to be faced in the foundry, but Mr. Gardom assured his hearers that the foundry manager was fully alive to the advantages of employing such a staff, and he felt sure that many failures were repeated and many ideas failed to reach fruition because the foundry manager had no one he could release from routine work to give attention, under his guidance, to those problems. To those Associations which were closely connected with the universities Mr. Gardom suggested that arrangements might perhaps be made for students, in their final year, to be sent to the foundries for three or four months to prepare a thesis on some everyday foundry problem, and to try to arrive at some conclusion with regard to it. Such a practice would be of great benefit to the industry, and he was quite sure that it would be of great advantage to the students in their training, and would enhance their prospects of obtaining suitable employment in the future. He coupled with the toast the name of Dr. S. W. Smith.

Progress Through Team Work.

Dr. S. W. Smith (Chairman of the London Local Section of the Institute of Metals), responding, said that the London Branch of the Institute of British Foundrymen had done the Institute of Metals a great honour by asking him to respond to the toast, and he expressed on behalf of the representatives of kindred associations present their appreciation of the hospitality extended to them. The interests of the Institute of Metals, he said, though concerned only with the non-ferrous metals, were nevertheless closely related to the interests which the Institute of British Foundrymen represented. The spirited expressions of disapproval which had resulted from the fact that the London meetings of the two bodies had been arranged to be held on the same evenings during the present session, amounting almost to the censure of the respective executives—(cries of "No!")—furnished one of the happiest auguries for the future, because these expressions of displeasure had proved how great was the desire of the members to share the benefits of the activities of both bodies. It was always refreshing to him to attend meetings of the Institute of British Foundrymen, and to hear the views of men who really handled molten metals in the foundry. Referring to the problem of modifying alloys, which had been discussed on the previous evening at the joint meeting of the London sections of the two bodies, he said that though admittedly nobody seemed to understand modification thoroughly, they knew that its effect was to render feeble alloys capable of doing all sorts of things which otherwise they would be incapable of doing. The demands of the engineer were becoming more and more severe, and the metallurgist was called upon to satisfy demands, in regard to both size and mechanical properties, which not long ago would have been regarded as unreasonable. The surprising thing to him was that the engineer so often obtained what he asked for. Under these conditions, team work was essential to successful production, and the only hope for continued progress; only by understanding each other's difficulties could we ensure, as we all desired to do, that British metallurgical practice would continue to lead the world. There were many instances in which the team spirit was being applied. One particular instance to which he referred was the long series of investigations which had been undertaken within the last few years by a strong committee under the auspices of the Iron and Steel Institute, into the processes and conditions of solidification and casting of large steel ingots. The Committee had already published two reports, and he believed that a third would follow. Leading firms, such as Messrs. Beardmore's, Cammell Laird, Vickers, and so on were represented on the Committee, and this was a striking instance of collective investigation, indicating that the heads of industry in this country realised the necessity for team work. There was also clear evidence of the close attention which was being given to the problems associated with the transfer of metal from the crucible or the furnace to the mould, one of the most troublesome operations which the metallurgist had to face. If only the metallurgists could dispense with that operation of transfer, they would all live happier, and perhaps longer lives. Those who had an abiding faith in metallurgical progress, however, felt that though at present we see only "as through a glass darkly," we were daily acquiring a clearer vision of many of the factors which made for successful work. Finally, on behalf of the representatives of kindred associations, Dr. Smith wished the Institute of British Foundrymen continued prosperity.



Front Cover of Programme.

Captain R. B. Crewdson, proposing the toast of "The London Branch and its Chairman," said he understood that the Branch had the honour of being the third largest in the country, having a

membership of 250, and that it contributed more money than any other Branch to the general expenses of the Institute. Further, two of its members had occupied the proud position of President of the Institute. The first was their old friend, Mr. "Jimmy" Ellis, whom they were all pleased to see looking still fit and strong, and the second was his friend and colleague, Mr. V. C. Faulkner. A third member of the Branch, Mr. Wesley Lambert, would be President of the Institute next year, and would hold that office on the occasion of the International Convention and Exhibition to be held in London in June. The members heartily wished him a very successful and prosperous year of office. (Applause.) Other members of the Branch to whom Captain Crewdson paid a tribute were Mr. H. G. Sommerfield (the Hon. Secretary and Treasurer), an extremely popular man throughout the industry, and the pride of the Branch; Mr. J. W. Gardom (Vice-President of the Branch), who had an extensive knowledge of the industry and was admirably fitted to fill the office of President of the Branch; and last, but not least, Mr. W. B. Lake, who was so popular, and whose popularity was such that he had filled the office of Branch-President for two years in succession. He was one of the great pioneers of the foundry industry, being one of the first, if not *the* first, steel founder to install an electric furnace, a sand slinger and a high-frequency unit. The London Branch, continued Captain Crewdson, was growing from strength to strength; it set a very high standard, it was a pride to the Institute as a whole, and must be a pride to its own members. Those who, like himself, were allied to the industry, though not actually part thereof, would receive the toast with a great deal of feeling, and wish the Branch, its President and its members generally all good luck and prosperity. He coupled with the toast the name of Mr. Lake.

WE'VE NO 'PIGS" SIR, SO THE BOSS HAS SENT YOU THIS!
I'M A BRASS FINISHER MISS —NOT A BASS FINISHER
SAMPLE CASTINGS
WANT AN APPRENTICE!
SCIENCE
RATIONALIZATION
PROGRESS
THEY SHOULD STICK THIS AT THE BOTTOM OF THE CHIMNEY
SUGGESTED ADVERTISEMENT FOR BINK'S MONKEY GLAND PASTILLES.
BAD TRADE
Mr. ROOTES SAID THE "BLAST" WOULD BE CONTINUOUS AND IT IS!
CROSS JOINTS

Back Cover of Programme.

The toast was received with enthusiasm, the company singing "He's a jolly good fellow" in respect of Mr. Lake.

The BRANCH-PRESIDENT, responding, said that it had not been his wish to occupy the office of Branch-President for a second year, but it had been pointed out to him that it was his duty, and he had accepted the office in that spirit. At the same time, he appreciated that the office was one which it was an honour to fill, not only because it was the presidency of the London Branch itself, but also because the Branch was an integral part of the Institute. He held the view very strongly that if this country was to compete successfully with the other nations of the world, there must be more combination and co-operation among the iron foundries—and he alluded to the proprietors particularly—than there had been in the past, in order that better technical facilities could be provided. Though the directors and proprietors of foundries had been somewhat apathetic in this connection, the Institute of British Foundrymen, the backbone of which consisted, as the President had rightly said, of foundry managers and foremen, had been alive to the situation, and the members had, at their own expense, and in their own time, combined to improve the technique in British foundries. Therefore, it was an honour to him to be assocated with the Institute. Discussing the demands made in respect of castings, he said he had been amused when an inquiry was made for some malleable castings, in respect of which it was specified that they must be as strong as steel, and as smooth and as sharply finished as stampings, permission being given to make them in any way which was thought best. He had thought that the inquirer had only to say that he wanted a grey cast iron with those qualities, and he would then have specified the ideal general purpose casting which foundrymen aimed at and which the engineering world was looking for. On second thoughts, however, his amusement had given way to serious thought, for, having in view the great progress which had been made and is still being made in all branches of science, the new instruments which were being placed in the hands of founders, and the new methods which were being devised, it was by no means impossible that in the future foundrymen would be able to produce such a casting as that which he had referred to as being the ideal. For instance, those who had seen in operation the Holley system of producing grey iron castings in permanent moulds must conclude that some day it would play a very important part. Again, new appliances for melting had been devised, as, for instance, the improved electric furnace, which had all the advantages of the crucible without its disadvantages and all the advantages of the electric furnace without its disadvantages. We must keep abreast of the times, and the best course for an ordinary foundryman to keep abreast of the times was to join the Institute of British Foundrymen, because the industry relied upon the Institute and upon its "Journal" to keep it abreast of the times. The President paid a tribute to the proprietors of THE FOUNDRY TRADE JOURNAL for the assistance they had given to the Institute, and particularly to the London Branch. They had placed their offices at the disposal of the members of the Branch Council for their meetings, and had helped in many other ways, and the members of the Branch were glad to have the opportunity to express their gratitude. They were also very grateful to the editor, Mr. V. C. Faulkner, for his efforts in the dissemination of knowledge. Finally, he alluded to the splendid work carried out by Mr. Sommerfield (the Branch Hon. Secretary and Treasurer), and endorsed all that Captain Crewdson had said of him. The Branch, he said, was served by the best secretary it could ever hope for.

During the evening an excellent musical programme was rendered, under the direction of Mr. H. Wharton Wells, B.Mus. The proceedings were brought to a close by the singing of "Auld Lang Syne."

Specifications for High-Grade Cast Iron.

At a meeting of the Newcastle Branch of the Institute of British Foundrymen, held in the Neville Hall, Newcastle-upon-Tyne, on November 24, 1928, Mr. H. J. Young (Past-President), of London, read a Paper on "A Consideration of the Various Claims for Producing High-Class Cast Iron," which has already been printed in our issue of November 26. Before the reading of the Paper, the prizes for the competition held the previous month were presented, the prizewinners being:—First, Mr. P. Reece, for his Paper on "Foundry Practice," and second, Mr. James Bell, for his Paper, "Castings for 'Nowt.'" He then called upon Mr. Young, whom he welcomed back to the Newcastle Branch, and who needed no introduction to the members, to read his Paper.

Mr. Gresty said the chief plea of Mr. Young was that engineers should state a specification which would get away from the unfairness that was caused by some foundries making metal which they called special and competing with other foundries which actually made special metal.

Test-Bar Situation.

Mr. V. Stobie (Past-President) said they all knew that a test-bar could be made to do anything but that a casting could do only what foundry practice enabled it to do. There was the case in almost every industry where a test will show what a material that has had certain treatment will do, but the material one bought had not always had that treatment. It was all a matter of competition, and the man who quoted a penny a ton cheaper got the order. In spite of that fact, there were firms who were able to quote higher prices and obtain the orders, because their work was known to be of a higher standard.

Type of Specifications Sought.

Mr. W. J. Molineux agreed with Mr. Young that the test-bar in cast iron and in some nonferrous metals did not represent the casting. If the casting was poured at such a temperature as to obtain the required test, the casting would be useless. He would like Mr. Young to take an instance, say, a Diesel engine liner or cylinder, and give them a specification. What would he specify? Would he give a specification for composition and the limits of that composition and the structure of that material? Would he specify the method of casting the material and how and where would he cut the test-bar, and what would be his test? He thought something of a concrete nature like that would be helpful to them. He did not think any of those present disagreed with anything Mr. Young had said.

In reply, Mr. Young said that to specify cast iron depended on the quality, the nature and purpose of the casting concerned. He would specify composition, certain physical tests and often structure.

Mr. Molineux asked if Mr. Young would not ask for any physical test, and was that the limit of what he would ask in any type of casting? Did he think that would cover the whole field, and was there a known specification that authorities were agreed upon?

Structure Should be Defined.

Mr. Young replied that in certain castings he would most certainly specify structure. In some cases he would specify impact, tensile and transverse tests. For some special castings, such as bedplates, the strength would have to be below certain figures, because failures occurred through the iron being "too strong." As to Mr. Molineux's point about authorities differing, he did not profess to be an authority. In the case of the firm he had mentioned, they put on the market a certain article of engineering use, and he had been appointed to decide what kind of cast iron should be used. By getting service results of one or two standard irons it was soon discovered which gave the best service. The only authority was that of practice, and the way to find the correct specification was to make or buy a standard iron and watch it in service.

Mr. A. Logan said that he thought everyone was in agreement with Mr. Young's Paper, which, like all Mr. Young's Papers, was interesting and to the point. The greatest value of that Paper would be in directing the attention of engineers to the question of specifications. Who was to blame for the lack of attention paid to that point? Mr. Logan added that he would like to know what Mr. Young considered would be the final solution of that problem, and what lines he would follow himself.

Locomotive Cylinders.

Mr. Young, replying to Mr. Logan, remarked that the question as to who was to blame was a little invidious. There were many sides to the question, and he thought that he had seen most of them. His opinion was that the blame was equally divided between the foundryman and the chemist. In the first place, there was the foundryman, who knew his own mixtures; he had heard a lot of discreditable tales about chemists, but he was going to have nothing to do with them. In the case of the chemist, if he did not have the courage to point out a better way the engineer could not know. The Admiralty could make specifications, and people would work to them; they already did that in the case of gunmetal, therefore why not cast iron? Railway companies ought to specify for locomotive cylinders. Of course, only specialised foundries could work on these lines, but they all ought to pull together and teach the engineer. If people were working in any specialty line of castings, where particular properties were required, surely they could afford to employ skilled advice and act on it. It was a perfectly simple matter. Taking, for instance, locomotive cylinders, hundredst of thousands were made, and if there was no metallurgic specification by now there ought to be, and easily could be.

Mr. W. J. Paulin asked how were they to get uniformity of treatment? Taking as an illustration certain fleets, the engineers were served out each month with a certain quantity of oil which was kept in a sealed can, and if he used more than that quantity he would get into trouble. Something, therefore, must be neglected, which was not fair on the iron, and all the trouble taken in the making of the casting went for nothing. On certain ships, oil was bought by the "expert buyer," and in order to save himself bother he would buy one kind of oil for all the work on the ship. It seemed outrageous. Turbine oil might be used for a light shaft as well as for a heavy thrust bearing. It seemed that the future Mr. Young looked forward to was hedged round by a good many dangers.

Mr. Young agreed that they did undoubtedly have much trouble put down to them which was due to neglect. He believed, however, that they could get cast-iron specifications, for the time was ripe for them.

Position Still Nebulous.

Mr. James Bell said that the discussion of Mr. Young's Paper had been distinctly interesting, but nothing absolutely concrete had come from either the Paper or the discussion. They were all agreed that certain specifications would be beneficial. Would it not be a good thing for the members of the Institute of British Foundrymen, who had had special experience in certain lines, to get together to discuss those specifications?

No Co-operation Sought.

Mr. Young replied that in his experience discussions were terrible things, and he did not think that that was the way to approach the question. He thought that if chemists and engineers pressed the point of *the need* for specifications, they would materialise naturally. He hoped the Institute of British Foundrymen would act single-handed. Once they had been the leaders of thought in cast iron and foundry work, and they were the people who were doing the job, and making the castings. When he said that the Newcastle Branch should take up the question he did not mean them to pass it on to the authorities, they should keep it in their own Institute's hands. It represented the foundrymen and the works metallurgists—the practical men—and they ought to be the chief ones to consider the details of these much-needed specifications.

Vote of Thanks.

Mr. Stobie proposed a vote of thanks to Mr. Young, which Mr. Allan seconded, Mr. Young suitably acknowledging.

The Electric Drive in Patternshops

By J. McLachlan.

In a patternshop in which the present writer spent part of his apprenticeship the machinery was driven by a gas engine. When all the machines were being used the load was too great for the engine, and there were frequent stoppages. If the engine was running satisfactorily, something would go wrong with a belt, and turning, sawing and planing would be stopped. The loss involved by those enforced stoppages did not worry the management for several years, but at last something had to be done, and, instead of installing a larger gas engine, the electric drive was adopted. The patternshop referred to was—and is still—very well equipped. It was one of the first patternshops to instal a "patternmaking" machine, as the wood miller is popularly called, and there was a machine that is now seldom seen, because the wood miller is so much more useful, a corebox machine.

In all but the largest patternshops there are times when all the machines are idle. The most used machine is the band saw, and after it perhaps the lathe comes next. In shops where only small work is made, such as motor-car shops and certain electrical shops, very little floor space is necessary between the machines, which can all be located close together, and without much regard to what machines are contiguous to each other; the timber is probably cut into short lengths by hand or swing saw in the timber shed. Driving belts, either overhead or on the floor, are not much in the way in small-work shops, therefore, but in marine and heavy electrical shops, the conditions are very different. Boards 15 to 16 ft. long have to be band-sawn and placed, consequently the machines have to be a considerable distance apart, and belts are a menace to safety. Some shops have adopted under-floor shafting to facilitate machine work, and there is much to be said for this, but more still for the individual electric drive.

Group Driving.

It is many years since the group electric drive began to be popular. In point of efficiency it is problematical whether it was better than the gas engine, and either separate gas engine or electric motor is more satisfactory than for patternshop machines to be driven by the same power unit as other workshops. In most cases where the electric motor replaced the gas engine it was a question of convenience, and not of relative efficiencies. The group drive in any shop where all the machines are not in use at one time means waste, because a higher power unit must be installed than is necessary; it must be sufficiently powerful to take the maximum load, and yet for half a working day not more than half of this may be necessary. In some patternshops there are fewer men than there are machines, and the patternshop is different from some other woodworking shops in that machine work is only auxiliary to bench work, which is an important point to consider in reference to the method of driving.

The most all-round satisfactory method of driving patternshop machines is the individual electric drive. At one time the objection was urged against the method that it was too positive; in other words, that a planing machine or a circular saw driven by a separate motor did not accommodate itself to the varying load, because one piece of wood will be hard and soft, wet and dry, and perhaps have several large knots. The belt-driven machine may be safer and more efficient if the driving speed is low, but the electrically-driven machine is operated at a high speed, and it is generally recognised that—apart from lathes—the higher the speed of a woodworking machine the more satisfactory are the results.

The individual electric drive is not new. It must be twenty years since the writer first visited a patternshop with all the machines thus driven. It was a jobbing patternshop, and the proprietor was wise enough to realise that low running costs were more important than small initial expenditure. Another factor that is often overlooked, but is important, is that when machines are driven by separate motors there is not as much noise.

(*Continued on page* 476.)

Production and Properties of Magnesium Alloy Castings.*

By E. Player (Coventry).

Introduction.

In recent years several interesting and excellent Papers have been read before various societies dealing with magnesium and its alloys. So far as the author is aware, however, none of these Papers has dealt with the practical side of the manufacture of magnesium alloy castings in any detail. It is in the belief that a description of the practical processes involved in the manufacture of such castings will be at least as interesting as a purely metallurgical thesis that this Paper is presented.

There still exists an impression that magnesium alloys, interesting though they are, yet remain in the experimental stage, and that their commercial production and application is some distance ahead. It is hoped that this Paper will show to engineers and metallurgists that this idea is erroneous. It will be seen from the data to be given and the examples quoted that the production of magnesium alloys in all forms is now on a strictly commercial scale of quantity, technical excellence and cost, thus offering the engineer a new material possessing many desirable qualities.

It is proposed to confine this Paper mainly to the manufacture, properties, and applications of magnesium-alloy castings, as obviously any attempt to deal with forgings, sheet, extrusions and the like demands too great a time and space. It should be stated that all the data quoted refer to the alloys known under the trade name of 'Elektron," magnesium being the base of these alloys, and this name will be used for the sake of convenience.

The author is indebted to the I.G. Farbenindustrie Aktiengesellschaft, Frankfurt on Main, and to Sterling Metals, Limited, Coventry, for permission to publish much of the information given, and it may here be mentioned that the first-named concern has not only pioneered the production of magnesium on a large scale, but has also developed the special technique which has made the manufacture of sound Elektron castings a commercial success.

History.

Magnesium was first isolated by Sir Humphrey Davy in 1808, and in the long period which has since elapsed it may be said that no appreciable progress towards commercial production and application was made till well on in the present century. Outside the laboratory, magnesium chiefly existed as photographers' flash powder and ribbon, and this fact has, unfortunately, created the general impression that magnesium is dangerous to use as an engineering material on account of its inflammability. The conception is, of course, entirely a mistaken one.

About 1907, the then Griesheim Elektron (now part of I.G.F.A.-G) began seriously to attempt the commercial production of magnesium metal, using as raw material $MgCl_2$, which was largely a waste by-product arising from the extraction of potassium salts from the Stassfurt beds in Germany. The process which was eventually successfully developed is briefly outlined below, and brings this short historical note up to the present day.

Production of Magnesium.

Magnesium is largely produced by the electrolysis of $MgCl_2$, the complete electrolyte consisting of this compound mixed with KCl or NaCl. The mineral carnallite, found in the Stassfurt beds, has been the chief source of supply hitherto. This is a double chloride of Mg and K, with the formula $MgCl_2.KCl.6H_2O$. Before charging into the cells, the carnallite must be dehydrated, after which the finely-powdered mineral is put into an iron pot, which forms the cathode. Carbon anodes are usually employed.

The mixture of chlorides is fused and simultaneously electrolysed by the current passed through it, chlorine being developed at the anode and magnesium discharged at the cathode. The necessity of disposing of the liberated chlorine harmlessly and the cost of dehydrating the carnallite have led to the development of a process using the oxide or carbonate as a base, these minerals being widely distributed. Where the carbonate is employed, it is first calcined to reduce the oxide. This is then mixed with powdered fluorides, such as CaF, which on being fused by the current in the cell, dissolve the MgO, and thus form a fluid electrolyte. An iron pot forms both container and cathode, and a carbon anode is used. Oxygen is liberated at the anode and burns to form CO_2 at the surface of the bath. Magnesium is deposited at the cathode, and is removed from time to time in a manner similar to that employed in the aluminium reduction cell.

The metal thus produced may be contaminated by up to 10 per cent. of electrolyte, which is removed by remelting under a suitable flux. The oxide process has the following advantages:—(1) The minerals used, $MgCO_3$ and MgO, are widely distributed in workable quantities, and are cheap; (2) no dangerous gases are evolved at the anode; and (3) the process is continuous. The resultant metal is of a high degree of purity, generally well over 99 per cent. pure.

Chemical Properties.

The outstanding characteristic of magnesium is its strong affinity at high temperatures for oxygen, and this one fact is responsible for most of the difficulties encountered in the reduction of the metal from its compounds, in manipulating its alloys in the furnace, forge and foundry mould, and in using the alloys for any wide range of engineering purposes. The means whereby these difficulties have been overcome constitute, in the author's opinion, the most interesting part of this Paper.

Magnesium combines with atmospheric oxygen when raised to a temperature of 650 deg C. As this reaction is productive of great heat, the temperature of the burning metal is raised sufficiently to cause the formation of nitrides through the combination of magnesium with atmospheric nitrogen. This latter reaction occurs at anything above 670 deg. C. approximately. Magnesium, in contrast to aluminium, is attacked by most acids, with the curious exception of hydrofluoric acid. On the other hand, it is practically unaffected by alkalies, not excluding powerful reagents like sodium and potassium hydrates, whether in the form of dilute or concentrated solutions. Magnesium and its alloys are attacked by saline solutions, such as sea water, to a greater extent than aluminium, and this fact has led to the development of special alloys and methods of coating which have greatly improved resistance to salt water corrosion. On exposure to ordinary atmospheric conditions, magnesium alloys become quickly coated with an oxide film which then acts as a protection against further attack. This characteristic is similar to that displayed by aluminium.

At sufficiently high temperatures, magnesium will attack silica and form Mg_2Si. It will be at once seen that this constituted an early problem which had to be solved before satisfactory sand castings could be produced. As magnesium also decomposes water rapidly at temperatures at or above its melting point (651 deg. C.), it will be appreciated that means had to be devised whereby, in pouring sand-moulded castings, reaction could be inhibited between the molten magnesium and the free moisture and/or the water of hydration in the clay bond of the moulding sand. Magnesium is unaffected by petrol, paraffin or lubricating oils, provided they are free from water and acids. The metal does not combine with sulphur either in the fused or solid condition, in this respect having an advantage over many other metals in common use.

It is now generally recognised that the corrosion of alloys is very frequently caused wholly or partly by electrolysis set up under suitable conditions between two of the metal constituents of the alloy, and this is confirmed by the undoubted fact that a chemically pure metal will nearly always exhibit a far greater resistance to a corrosive reagent than any of its alloys. If this is admitted, it will be obvious that, in seeking a magnesium alloy which will possess the greatest possible resistance to corrosion, a first step will be to select, as alloying constituents, those metals which stand nearest to magnesium in the electrochemical series, provided always that such selected metals produce alloys with good working qualities and physical properties.

TABLE I.—*Electro-Chemical Series of Metals.*

1. Calcium	17. Nickel.
2. Rubidium.	18. Tin.
3. Potassium.	19. Lead.
4. Sodium.	20. (Hydrogen).
5. Lithium.	21. Antimony.
6. Barium.	22. Bismuth.
7, Strontium.	23. Arsenic.
8. Calcium.	24. Copper.
9. *Magnesium.*	25. Mercury.
10. Aluminium.	26. Silver.
11. Chromium.	27. Palladium.
12. Manganese.	28. Platinium.
13. Zinc.	29. Gold.
14. Cadmium.	30. Iridium.
15. Iron.	31. Rhodium.
16. Cobalt.	32. Osmium.

It will be seen from Table I, showing the relative positions of the various metals in the electrochemical series, that magnesium is electro-positive to all the metals commonly employed in engineering practice. Thus any metals which can be used to improve the physical properties of pure magnesium will be electro negative to the matrix metal. For reasons so obvious that they need not be detailed, the choice is really confined in practice to the following:—Aluminium; manganese; zinc; iron; nickel; tin; lead; and copper; with the addition of the metalloid silicon.

Of these eight metals, iron does not alloy with Mg, and the alloys of nickel, tin and lead, have so far shown no very useful properties, whilst the copper alloys have serious disadvantages. Thus the selection narrows down to aluminium, manganese, zinc and silicon. Magnesium forms alloys with zinc, aluminium and copper which have excellent casting qualities and physical properties.

As might be expected from its relative position in the electro-chemical series, however, copper forms alloys which are very subject to corrosion under certain conditions commonly met with, such as exposure to damp atmospheres, this arising from the galvanic action set up between the magnesium and the copper. For this reason, copper does not form a principal constituent of any of the Elektron alloys. Aluminium and zinc, however, as will be appreciated from what has been said, form binary and ternary alloys with magnesium which not only have good physical properties, but are, in addition, satisfactorily resistant to corrosion under all ordinary working conditions.

Manganese, whilst not exercising any noteworthy influence in improving the physical properties of the alloys, has a pronounced effect in improving resistance to corrosion, and for this reason a small amount, generally about 0.30 per cent., forms an essential part of all Elektron alloys. Higher percentages do not make observable improvement.

Alloy AS.82, composition of which is given in Table II, contains 2 per cent. silicon, and is susceptible to hardening when subjected to a suitable heat treatment.

Table II gives details of the composition of the various Elektron alloys which are used in the production of castings, forgings, etc.

The alloy AZG is now chiefly used for sand castings, having a somewhat higher yield point than the older alloy AZF, whilst still giving a somewhat higher elongation than aluminium alloy

* A Paper read before the Birmingham Metallurgical Society.

L.5. V1 is specially suitable for die castings, being less subject to hot shortness than the zinc bearing alloys. It is also useful in the sand foundry where castings of greater hardness and rigidity are required than can be obtained from AZG alloy, with lower elongation. All the alloys classed as for forgings are used for the production of stampings and extruded sections, having various physical properties to suit a variety of requirements.

Table II.—*Composition of Elektron Alloys.*

Symbol application.	Zn.	Al.	Si.	Cu.	Mn.	Melting point. Deg.C.
AZF sand castings ..	3.0	4.0	0.3	0.3	0.35	635
AZG sand castings ..	3.0	6.0	0.3	0.3	0.35	635
V1 die castings and forgings ..	0.6	10.0	0.3	0.3	0.35	635
AZ31 forgings	1.0	3.0	0.3	0.3	0.35	
AS.82 „	0.5	8.0	2.0	0.3	0.35	
AZM forgings and sheets	1.0	6.3	0.2	—	0.35	

Physical Properties of Elektron Castings.

Strength.

The characteristic of Elektron alloys which is of most interest to the engineer is undoubtedly the low specific gravity combined with good mechanical strength. The S.G. of Elektron averages 1.82 as against those of the usual aluminium alloys 2.83 to 3.0. Table III gives the approximate specific gravities of the metals and alloys commonly employed in engineering construction.

Table III.—*Specific Gravities.*

Metal.	Specific gravity.	Density factor.
Elektron	1.82	1.0
Aluminium L5	2.95	1.62
Aluminium L11	2.85	1.56
Aluminium 11 per cent. Si. ..	2.66	1.46
Steel	7.8	4.25
Cast-iron	7.2	3.94
Cast brass	8.6	4.7
Extruded brass	8.6	4.7

This low S.G. would, of course, be of little service to the engineer unless accompanied by reasonably good strength values. In this respect, Elektron has much the same characteristics as the usual aluminium alloys, and Table IV indicates the relative strength of various engineering alloys, including Elektron.

Table IV.—*Mechanical Properties of Sand Castings.*

Material.	Y.P.	M.S.	E. per cent.	Brinell	S.G.	M.S./S.G.
Elektron A.Z.G. ..	6–7	9–11	4	50–60	1.82	5.5
Aluminium L5 ..	6–7	9–11	3	50–60	2.95	3.4
Aluminium L11 ..	7.2	9–10	2	60	2.85	3.33
Aluminium Sil (Mod.)		12	8		2.66	4.5
"Y" Alloy as cast ..	10	11.9	1.5	89	2.80	4.2
"Y" alloy heat-treated	13.9	14.7	1	100	2.80	5.25
70/30 Brass	6.5	13.15	30–40	50	8.6	1.7
Cast steel ..	17–19	28.32	10–12	150	7.8	3.35
Cast iron ..		11.15	Nil		7.2	1.8
Malleable cast iron	13–17	20–24	6	150	7.2	3.1

The mass-strength ratio (M.S./S.G.) is calculated by dividing the mean of the figures given for each metal in the ultimate strength column, by the specific gravity of the metal. It will be at once seen that this ratio is a valuable guide in selecting the most suitable metal for any particular duty, and, aside from such considerations as cost, chemical properties, etc., it will be found that, generally speaking, metal is most suitable which offers the lowest total weight whilst possessing a given standard of mechanical properties. The figures quoted in the tables are necessarily approximate, but may be accepted as results usually to be looked for in general engineering practice.

Table V.—*Mechanical Properties of Wrought Alloys.*

Material.	Y.P.	M.S.	E. per cent.	Brinell	S.G.	M.S. S.G.
Elektron V1 w. quenched	15–17	22–24	8–10	70	1.82	12.6
Elektron V1 h. aged ..	16–18	22–26	2–3	85–90	1.82	13.2
Elektron AZM as forged ..	15–17	20–24	10–12	65–70	1.82	12.1
Elektron or rolled ..	15–17	18–20	8–10	60–65	1.82	10.4
Elektron SZ	8.10	14–16	10–15	44	1.82	8.2
Duralu m i n, aged ..	18–20	24–27	10–15	100	2.80	9.1
Duralu m i n, annealed	12–14	20–24	15–20	60–80	2.80	7.9
"Y" Alloy heat-treated	15	20–25	10–20	100	2.80	8.05
60/40 Brass	16	25	20	120	8.6	2.9
Mang. bronze	18–20	35	25	130	8.6	4.05
Mild steel ..	22	38	33	149	7.8	4.85

In the table referring to sand castings, the results are those usually to be obtained from sand cast test bars, correctly poured. Chill cast bars will always show results from 25 to 50 per cent. higher in ultimate stress and elongation, both on magnesium and aluminium alloys. The tables showing the strength figures for the various metals used in engineering are largely self-explanatory. It will be noticed that the elektron alloy AZG has, in the sand condition, physical characteristics very similar to those of aluminium L5 alloy, though it is, of course, approximately 40 per cent. lighter.

It is interesting to observe that only one casting alloy shows a mass-strength ratio approaching that of Elektron AZG, this being "Y" alloy in the heat-treated condition. There are, however, as is well known, many serious difficulties in producing large "Y"-alloy sand castings that are thoroughly sound and free from cracks, draws and pin holing. These difficulties do not exist to anything like the same extent in the case of elektron, and, furthermore, expensive and difficult heat treatment is necessary to obtain the relatively high figures instanced for "Y" alloy. The Elektron alloy V1 (10 per cent. Al. 90 Mg.) has stress figures very similar to those of aluminium alloy 2L11. Shock resistance is at least equal to that of the aluminium alloys, and liability to deformation under stress is less than is the case with the aluminium-silicon alloys. Rigidity is good, though not, of course, equal to that of cast iron.

Machine Shop Practice.

All the magnesium alloys possess excellent machining qualities, in this respect comparing favourably with aluminium. The latter metal is rather difficult to handle where fine threads and specially smooth finish are required. Magnesium alloys can be machined at considerably higher speeds than nearly all other metals, and fine and accurate finish obtained without the necessity of costly finishing operations. These properties are of considerable value in modern manufacturing operations, where speed of operation usually means lower costs. No lubricants should be used in machining, and all trimmings and swarf should be frequently removed from machines and stored in closed metal bins to prevent deterioration through oxidation, and also to avoid any risk of fire from carelessly thrown matches, etc. In the event of swarf or turnings becoming ignited, water should not be used as an extinguisher. The combustion can be smothered by liberally covering the burning swarf with dry sand.

Foundry Practice.

Melting.

Molten magnesium on exposure to the atmosphere rapidly forms oxides and nitrides, which, having almost the same specific gravity as metal itself, become disseminated through the bath and contaminate the metal. Little real progress in the production of sound castings could be made until this initial difficulty was overcome. Various methods were tried, such as melting *in vacuo*, under inert gas and so on. Either for technical or practical reasons, none of these attempts succeeded. Magnesium chloride suggests itself as a possible flux, being in the fused condition, a solvent for the oxides and nitrides of magnesium. Unfortunately the use of this material alone in ordinary foundry practice is almost impossible, as, when used alone, it is too fluid in the fused condition, and may enter the mould with the metal in pouring.

Working on this basis, however, a compound flux known as Elrasal has been evolved, which very satisfactorily solves the melting problem of magnesium alloys. The basis of Elrasal is magnesium chloride, with the addition of other salts which on fusing form a viscous flux which does not readily dissociate at high temperatures. The molten surface is kept covered with a skin of the flux till the whole charge is melted, when the temperature is raised to ensure the complete fusion of the flux. The bath is then stirred thoroughly to bring all the metal in contact with the viscous flux, which dissolves all entrained oxides and nitrides during the stirring process, and sinks to the bottom of the crucible. The surface of the metal is then completely covered with an additional amount of Elrasal, which fuses and forms a tenuous covering which protects from surface oxidation. In pouring the casting, this surface skin is held back by a skimmer, and, owing to its inherent tenacity, does not flow or break away and so enter the mould with the metal.

Where the melting process described is carried out carefully, the metal losses during the melting process should not exceed 1 to 1½ per cent. The author has proved, over a number of years of routine foundry experience, dealing with castings, large and small, that this process ensures absolutely clean metal being delivered to the moulds, provided the furnaceman knows his job and exercises reasonable care.

Wrought-iron or mild-steel crucibles are used for melting, as magnesium does not, like aluminium, readily alloy with iron, and the crucible is never attacked by the molten metal. Plumbago crucibles are unsuitable, as the molten metal will attack the silicon compounds employed in the manufacture of graphite crucibles. Cast-iron crucibles can be used for small sizes, but weight limits their use in larger capacities. For very large melting units, where cranes are available, cast-steel pots are suitable.

Failure of iron crucibles always occurs through scaling in the furnace, and it is therefore necessary, as far as possible, to employ a reducing atmosphere in the furnace. Calorised and chromium-plated crucibles give a considerably longer life, but the author has found, up to the present, that the increased cost more than outweighs the increased life. The pouring temperature of magnesium alloys may range between 680 deg. C. for thick section castings to 780 deg. C. for thin work.

A notable property of Elektron alloys is that castings thoroughly sound and free from cracks and draws can be poured over this wide range of temperature, which certainly is not the case with most aluminium alloys, in which cracking due to hot pouring is a great source of trouble in the foundry, especially on thin sections. This feature is largely due to the ideal cleansing conditions of the melting process, and also to the inherent characteristics of the alloys of magnesium, which are less liable to the trouble known to the founder as "hot shortness" than are the usual aluminium alloys. Another interesting feature of the magnesium alloys, when melted under the conditions outlined, is that resultant castings are entirely free from that defect, which causes so much trouble in the aluminium foundry, known, for want of a better name, as "pin-holing" or "specky metal." These desirable properties largely offset the extra care required in the melting and moulding processes. Where maximum strength is required in the casting, it is always advisable to

pour at the lowest temperature that will ensure a sound and completely run casting.

Moulding.

From the readiness with which molten magnesium decomposes water, it will be appreciated that, in the early stages of development, the problem of producing sound, clean castings in sand moulds appeared almost insoluble. Magnesium poured into an ordinary green-sand mould will be ejected with a force almost amounting to an explosion, due to the great volume of hydrogen liberated from the moisture in the mould. The use of perfectly dried moulds appeared the natural solution, and for some years this method was followed, with, however, indifferent results.

Prolonged drying at relatively high temperature, say, 400 deg. C., will drive out the free moisture in the sand, but even so, castings made in this manner show patches of surface oxidation and are dirty and blown when broken. This is due partly to reaction with the water of hydration in the clay which forms a small but necessary proportion of all moulding sands, and partly to reaction with air-borne moisture which inevitably fills all the pores of the mould when the latter is allowed to cool to safe pouring temperatures. If the mould-drying temperature is raised sufficiently to drive off the water of hydration in the clay bond, the bond of the sand is destroyed, and the mould will crumble. Apart from these serious technical defects, the method is slow and costly.

The wastage of metal due to oxidation by this process is an additional serious financial loss. Attempts were made to cast after filling the mould with a gas more or less inert to magnesium, for instance, CO_2. This also proved a failure, as the method did not prevent the mould steam from coming in contact with the metal. Further disadvantages were the obvious difficulty of applying the process in ordinary foundry practice, and the cost of the operation. From the failure of this experiment the opinion was formed that it would be necessary to surround each grain of moulding sand in the neighbourhood of the metal with a complete pellicle of some substance, itself inert to molten magnesium, preferably with a strong affinity for oxygen, and of such a nature that, whilst freely penetrating all the pores of the mould, it would not readily escape and so leave the sand surface layers unprotected.

To be brief, the desired substance was found in sulphur, which is mixed, in small proportions together with a less quantity of boric acid, with ordinary moulding sand. This process is patented, and in several years' continuous experience the author has proved it uniformly successful in producing thoroughly sound and clean castings in every way, provided ordinary care and intelligence are used. The molten metal entering the mould instantly vaporises the powdered sulphur in the surface layer of sand, forming a protective layer between the metal and the moisture in the sand. A small proportion of the vapour probably combines with the free air in the mould to form SO_2.

The vapour evolved is sufficiently fluid to penetrate the mould pores and surround each grain of sand, but, being heavy, does not escape readily, and, further, is constantly replenished by the gradual vaporisation of sulphur deeper in the sand as the heat penetrates the mould. As the casting freezes and cools off, most of the sulphur vapour condenses in the sand again, so that there is little loss of this medium. The moulds are cast green by this process, though it is advisable to skin dry large and important moulds, as is the case with aluminium, to avoid risk of seaming and surface blow-holes.

From time to time the small amount of sulphur and boric acid which is driven off from the surface of the mould requires replacing, the necessary amounts being added when the sand is passed through sand-mixing machines of the usual type. Alternatively, sulphur and boric acid may be added only to new sand used for core making, the old cores after use being added to the mould sand and thus replenishing the protective reagents. The special moulding-sand preparation described, together with the melting process employing Elrasal as a protective and solvent flux, form the basis of successful production of Elektron alloy castings as the author knows it. In other respects practice follows very much on aluminium foundry lines.

Core Making.

Cores are made in sand similar to that used for moulds, dried at a temperature not exceeding 100 deg. C., to avoid vaporising the sulphur. Cores should be permeable and not too hard, as for aluminium. A smaller percentage of sulphur is needed in core sand, as most of the sand moisture is removed in drying the cores. Core sand does not require so large a percentage of sulphur addition as mould sand, as owing to the drying process to which cores are submitted there is much less moisture to be counteracted.

Chills are required on heavy bosses and increased sections where direct feeding is not practicable, and these may be either in brass, aluminium with 5 per cent. iron, copper or magnesium, or in cast iron. It is specially important to give chills a surface dressing of such a nature to prevent moisture condensing on them, otherwise blow-holes and oxide inclusions will be formed when the metal comes into contact with a moist chill.

Experience has shown that a mixture of fine graphite in methylated spirits give good results. The graphite should contain not less than 85 per cent. carbon, and the mixture should be sprayed on to the chills. If brushed on, the surface pores and irregularities of the chills are not filled up, but only coated with the mixture, and blowing may take place. Wherever possible, Elektron castings should be poured from the bottom, tranquil filling of the mould being most important.

Both aluminium and magnesium have a highly tenacious oxide skin when in the molten state, and air bubbles entrapped through undue agitation of the metal when pouring are frequently unable to break through the film of oxide surrounding them and remain in the metal. For the same reason, the crucible should be held as near as possible to the runner bush when pouring, and the latter kept full until the pouring is finished, to avoid air being sucked into the mould with the metal. When this is done, the metal actually flows through a stationary, though flexible, tube of oxide skin, so that the Elektron enters the mould in complete isolation from the atmosphere, and consequently free from oxidation. Heavy sections require adequate feeders, and, when unusually massive in relation to the adjacent parts of the casting, require well chilling in addition.

Trimming.

In trimming or fettling Elektron castings, the practice usual in aluminium foundries is followed, with the exception that it is not advisable to use emery wheels for grinding purposes, as the fine metallic dust given off by these may quite ignite if lights are carelessly handled in the immediate vicinity. Bandsaws are used for removing the runners and risers, the finishing being carried out by pneumatic or hand chisels, and files.

Protection Against Corrosion.

Very considerable protection against corrosion is secured by subjecting the castings to a dipping process in a bath of dilute nitric acid with a proportion of potassium bichromate in solution. This has the effect of removing the film of iron and iron oxide which the skin of the casting acquires from contact with the moulding sand, and replaces it with a golden coloured skin, which is very resistant to all usual corrosive influences, such as damp atmospheres, etc. If further protection is desired, the Elektron casting can be coated, when ready for assembly in the structure of which it forms a part, with any good enamel, those with a cellulose base having been found particularly good both in adhesive qualities and indifference to external chemical influence.

Die Castings.

Elektron alloys are now employed in the production of die castings, and also, to a lesser degree, of permanent-mould castings. Where aluminium is used for this purpose, there is always the difficulty caused by the erosive effect of the aluminium on the steel of the die, due to the tendency to form an alloy of iron and aluminium, which tendency is aggravated by the high speed and pressure at which the metal enters the die. This action necessitates frequent renewal of die parts to maintain the die in working order, and retain the original accuracy of the castings. Elektron alloys are peculiarly suitable for use in the manufacture of pressure die castings, owing to the fact that magnesium does not alloy to any appreciable degree with iron. It is thus possible to produce castings of great accuracy in large numbers from one die, and where large quantities of one design are required, considerable economies can be made, as it is usually possible to eliminate entirely many machining operations which would otherwise be required.

An unusually high pressure is used in the special machines designed for Elektron pressure casting, making it possible to handle relatively difficult and thin castings, sections down to 1 mm. thick being possible on suitable designs. The production of gravity die castings is as yet in its infancy, as there are several technical difficulties still to be overcome. It is obviously impossible to employ in a metal mould the same protection against oxidation as is obtained by the sand-moulding process already described, and thus, up to the present, permanent mould castings are frequently defective owing to oxide skin inclusions formed as the metal enters the mould, especially where thin sections occur. Progress is being made, however, and it is quite probable that Elektron castings made in permanent moulds will be obtainable as readily as aluminium die castings are to-day, and equally as sound.

Application of Elektron Castings.

A study of the table of mass-strength ratios will at once indicate that Elektron can be employed with advantage in many engineering structures. The very existence of modern civilisation largely depends on the products of the engineer. All kinetic machinery consumes power, and is liable to frictional wear in the moving parts. If, therefore, the weight of such parts can be substantially reduced without sacrifice of the required strength and rigidity, it is apparent that there will be a reduction in the power consumption of the machine, due to the lowering of the inertia losses and reduced friction losses. This is more particularly the case with parts having intermittent or reciprocating motion.

In the design and construction of mechanically-propelled road vehicles and aircraft, the necessity for a high power-weight ratio has, of course, always been recognised, with the result that aluminium alloys play a large part in their construction. In the field of general engineering, however, the author is of opinion that this point had not received the attention it deserves, and there are doubtless many types of machines where light alloys such as Elektron could be employed with considerable advantage, resulting in lower running and maintenance costs, and higher working speeds.

Naturally questions of cost, suitability of such light alloy to the chemical and physical conditions under which it must work, must all be taken into account, but it is highly probable that in many instances the financial gain arising from lower power consumption, less frictional wear, and increased speeds and output, would more than offset a certain increase in initial cost of construction. Such weight reductions are frequently cumulative, and therefore greater than would at first appear. Each moving part of the machine must transmit not only the useful power, but also the considerable surplus power required to overcome inertia and friction in the correlated parts.

If a substantial reduction is made in the weight of one component, it is obvious that the weight of those parts connected with it can be safely reduced by employing a smaller section (and weight) than was previously the case, as the total power required to be transmitted is lowered by the saving of inertia and frictional losses in the light metal part, although the useful power transmitted remains the same. Thus, if Elektron castings are used instead of iron castings for the moving parts of a machine, it is possible to reduce the weight of these parts by at least 66 per cent., without sacrifice of strength (see Mass-strength Table), and a further reduction may be due to the lower power now required to overcome inertia and frictional losses, particularly in reciprocating or intermittently moving parts. These considera-

tions, plus the exceptionally good machining qualities of Elektron, have already led to the wide adoption of the alloys for a variety of engineering purposes. First in point of quantities used is the heavy motor vehicle industry. Here dead weight must be reduced to the safe minimum, so that the useful load may be increased, and, in some cases, the highway authorities satisfied.

Elektron crank cases, gear boxes, and various other parts are successfully used in large quantities by a number of manufacturers. The reduction in unsprung weight in such vehicles is even more important, as tending to quicker acceleration and more effective braking, longer tyre life, less road destruction, and smoother travel of passenger vehicles.

Cast Elektron road wheels are rapidly replacing steel wheels on the omnibuses in one Continental capital city, after exhaustive trials. Table VI shows the weight reductions effected by the change, with substantial advantages.

TABLE VI.—*Relative weight of cast road wheels.*

Material.	Front wheel.	Rear wheel.
	lbs.	lbs.
Elektron	24	92
Cast steel	145	246
Saving per wheel ..	97	154

Total saved per vehicle, 505 lbs.

Hitherto the motor-car manufacturer has in many cases adopted, where possible, cheap materials, such as cast iron, with a view to lower production costs. There is now an increasing tendency to aim at a lower dead weight for private cars, as running costs and general maintenance expenses can be reduced where this end is attained. Also, with the higher speeds now general on our roads, the improved braking effect consequent upon low dead weight is a very important advantage. This extensive use of Elektron enables a substantial weight reduction to be effected without undue cost increases. It will be appreciated that high power weight ratio is a more important factor in any vehicle than the simple power output of the engine, other things being equal. Thus the substitution of Elektron for heavier materials in the construction of high-grade cars has appreciably increased the power weight ratio by reducing the dead weight, giving the effect of enhanced engine output without increased running costs.

Coming next to the aircraft field, it will be expected that Elektron has aroused considerable interest among designers and constructors. As with all new materials there have been technical difficulties to overcome, and a very praiseworthy caution on the part of constructors has necessitated prolonged testing of the material under service conditions. Upon the whole it may be said that results indicate that magnesium-alloy castings will in the future take an important place in the construction of engines for aircraft, the possibilities of weight reduction being too attractive to be ignored. The definite advance made in the resistance to sea-water corrosion by the alloying and surface treatments previously referred to have greatly enhanced the usefulness of the Elektron alloys in this field, although for purely seaplane work further improvement is required and is being sought.

Forms for moulding rubber tyres have a considerable weight advantage over either cast iron or aluminium, with the additional special qualities that Elektron is entirely unaffected by sulphur during the moulding process, and machine up with a very smooth non-porous surface free from blow holes or pin holes. Castings of this size and section are not easy to produce in any other metal with that high degree of finish and soundness that is requisite in such a process as tyre moulding.

The next group of casting includes pistons for high speed air compressors, where the lowest possible reciprocating weight is an essential, wheels for textile machinery, railway carriage ventilator and other parts.

Sheet Metal.

Elektron rolled sheet is finding increasing application in constructional engineering, especially in aircraft building. This has been particularly the case since the very difficult problem of making a satisfactory welded joint was solved. Extremely light but sound petrol and oil tanks, spars, etc., are now being produced. The sheet can be worked to most shapes, but where pressed in deep forms, the work must be carried out in a number of stages, and the article suitably annealed after each operation. Disc landing wheels for aircraft and road wheels for cars also employ Elektron sheet.

Conclusion.

The author hopes that this brief survey of the present state of the technique of magnesium-alloy casting production will arouse a greater interest among engineers as to the great possibilities opened up now that the metal is commercially available. It is not suggested that finality has been reached, but undoubtedly there has been laid a solid technical foundation upon which future developments can be safely built. In concluding, the author wishes to acknowledge his indebtedness to his colleague, Mr. H. J. Goodwin, for his help in preparing the various photographs used.

The Application of Welding in Iron and Steel Works.

EXPERIENCE IN GERMANY.

Both oxy-acetylene and arc welding are extensively employed in German iron and steel works. The oxygen required for the former system is mainly produced by the works themselves, and, in the case of fairly large plants, the acetylene also. At the August Thyssen works, Hamborn-on-Rhine, there has been installed an oxygen generating plant formed of two units, each with an output of 60 cub. m. per hour.* The oxygen is produced of 99.8 per cent. purity and is led to the three workshops in which it is employed, via a system of piping and storage tanks.

Two generators, with a combined capacity of 20,000 litres, supply the acetylene, which is likewise fed to the points of usage by pipe line. Gangs moving about on repair jobs have, of course, to take oxygen cylinders with them, together with small carbide generators for the acetylene. The gear in use at the Thyssen works comprises 84 cutting blowpipes, 60 welding blowpipes, and 60 transportable acetylene generators. Per month, 30,000 cub. m. of oxygen are used, and 1,200 cub. m. acetylene (taking into consideration only that which is produced in the central generating plant). The total consumption of carbide, each kilogram of which gives 250 litres acetylene, is 24 tons a month.

Costs of Oxygen and Acetylene.

The costs of producing the gases, reckoning in interest and depreciation, amount, for the acetylene, to approximate 1.50 marks per cub. m., and, for the oxygen, 0.25 marks per cub. m. The price of oxygen, in the open market, is about 0.50 marks per cub. m. in cylinders, large consumers obtaining it on contract at 0.35 marks. Of electrical welding it can be said that both arc welding and resistance welding are in use, but the latter has not yet been introduced on an extensive scale—apart from process work in certain individual concerns.

Two modifications of arc welding can be distinguished, according to whether the work is preheated or not before commencing to weld. In general, a centrally-situated plant is laid down for the pre-heated welding of cast iron, to which the parts to be repaired are sent. Where preheating has not to be resorted to it has been found best to carry out the welding on the spot with a small welding set, in order to save transporting the parts over what might be a considerable distance.

Welding Dynamos.

As the voltage required in arc welding is mainly in the neighbourhood of only 20 to 30 volts it would be extremely wasteful to take the current direct from mains at the normal supply pressure, as resistances would have to be inserted in the circuit. For this reason, and to permit individual regulation for the particular work in hand, it is usual to employ, in practice, a special, separate welding generator for each job. These small generators are mostly coupled several to a common driving motor, mainly in sets of four or two. This, of course, applies to stationary equipment; the transportable sets consist of a simple motor-generator.

Whether D.C. or A.C. is the more suitable for welding has remained a debatable question: reliable welds can be executed with both types of current. General opinion has hitherto favoured direct current, as alternating current welding transformers have only recently attained a practical stage of development. In the welding of cast iron, when the pre-heating process is applied, the casting is first brought up to a dull red heat and then—employing a cast-iron electrode and a fairly heavy current, 200 to 400 amps. D.C. at about 65 v.—melted to a considerable depth. The weld, if care is taken, especially with the cooling, is homogeneous, and can be readily worked.

The welding of cast iron, without pre-heatig, by means of a steal electrode involves certain difficulties, as in the boundary layer between the cast iron and the added filling metal there form regions of hard material, entirely unsuited for tensile stresses. To overcome the consequences of this fact the use of studs or pegs is resorted to, the studs being screwed into the casting and their heads welded into the filling material. These studs relieve the hard intermediate layer and transmit stresses from the weld to the original metal of the casting.

Economic Advantages.

The economic benefits of welding are beyond all doubt. At the August-Thyssen-Hütte there are four electric welding installations in service in different parts of the works. Near the blast furnaces there is located a central plant for preheated welding, together with a department for welding without pre-heating, and one plant for the latter type of welding is situated in each of the steelworks Nos. I and II. The calculation of the sums which were saved by the electric welding of broken or worn machine parts brings home the remarkable economies effected.

Under the assumption that the welding plants operated at a cost of approximately 70 per cent., the cost of repairs were determined for each article welded. If the article or part would have had to be scrapped, a sum would have to be expended to replace it equal to the value of the new casting less the value of the old one as scrap. The amount thus arrived at has to be compared with the cost of repair by electrical welding.

In the case of the four welding plants just mentioned the savings, as thus determined, amounted in eight months to approximately £9,490. This is assuming the welded casting to be equal to a new one, which, of course, is not quite correct. However, it is quite safe to value the welded part at half the cost of a new casting, and even then the saving effected in eight months by about 10 arc welding points is as much as £4,500.

Apart from the direct saving in money realised, the possession of welding plant offers many indirect advantages in the way of time saving and the readiness with which breakdowns of machines can often be remedied. A smaller stock of spares for the last-mentioned can also be carried.—Abstracted from a detailed survey published in "Arch. Eisenhüttenwes.," 2 (1928-29), pp 87-97.

* It is interesting to note that Messrs. Kryn & Lahy, steel founders, of Letchworth, are also operating a plant of considerable magnitude for the generation of oxygen.—EDITOR.

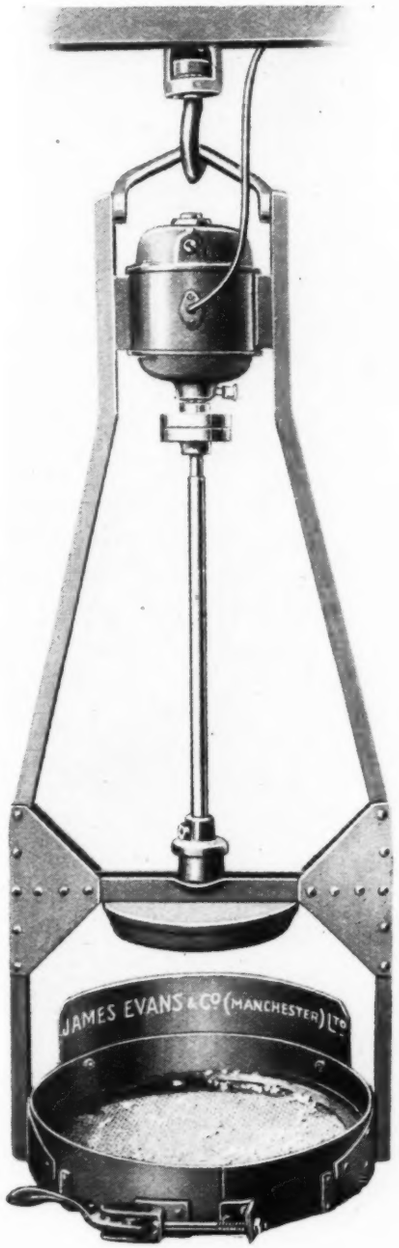
The Electric Drive in Patternshops.

(*Continued from page* 472.)

Also the machines can be placed wherever most convenient, and floor space can thus be economised.

Until quite recently the motors for woodworking machines were separate units apart from the machines, but in modern practice built-in motors are used on many machines with push-button control, and designed for reverse current breaking to provide for quick stopping. There is much in favour of machines so driven, and they represent a big advance on all other methods of driving woodworking machines.

EVANS'S ELECTRIC
GYRATORY FOUNDRY RIDDLE



THE saving accomplished by the use of our Electric Gyratory Riddle pays for the cost of the machine in a few weeks' time.

It will sift more sand with one operator than six men sifting by hand. In addition to this it mixes the sand better, and produces a better grade than hand labour.

The machine is portable and may be moved to any place in a few moments (where a hook for suspension is available and electric current in service) and set in motion instantly.

Motor and working parts are all above the sieve, thus preventing the sand from interfering with the operation of the machine.

Power required, ¼ B.H.P.

JAMES EVANS & CO. (M/c) LTD.

Britannia Works, BLACKFRIARS, MANCHESTER

Trade Talk.

The Steel Export Company, Limited, have removed from 52, Gracechurch Street, to Gort House, 74, Great Tower Street, London, E.C.3.

Industrial Constructions, Limited, have transferred their offices from 44, Grosvenor Place to 54, Victoria Street, London, S.W.1.

Messrs. Heinrich Lanz A.G., of Mannheim, Germany, have just sold their first licence for the United States to the Eastern Steel Castings, Limited, of Newark, New Jersey, U.S.A.

The title of Willson Goggles, Inc., has been changed to Willson Products, Inc. This American firm is represented in Great Britain by S. Pulzer & Son, Limited, of 45, Hatton Garden, London, E.C.1.

Mr. A. K. Steven, chairman of the board of management of the Royal Metal Trades Pension and Benevolent Society, is appealing to subscribers to use their best endeavours to obtain at least one new subscriber during 1929. The voting papers now in course of issue contain an invitation to all present subscribers to join in this effort.

The new power station which is being constructed for the Bristol Corporation at Portishead is to be advanced a stage further in its development by the addition of a 50,000-kw. turbo-alternator set, which, together with important extensions to the boiler plant, switchgear and transformer equipment, has just been ordered from the Metropolitan-Vickers Electrical Company, Limited.

Messrs. James Booth & Company, of Birmingham, have placed a repeat order for Monometer 500 lbs. central axis tilting furnace, whilst other orders for Monometer furnaces have been received from Widney Manufacturing Company and Messrs. Joblings & Company, Limited, of Sunderland, by Sir W. G. Armstrong, Whitworth & Company, Limited, Kinnaird House, Pall Mall East, London, S.W.1.

The South African Railways Administration have accepted the tender of Messrs. Cammell, Laird & Company, Limited, for 600 steel drop-sided bogie wagons, each of 80,000 lb. capacity, costing £225,000. The actual building of the wagons will be done by the company's associated concern, the Leeds Forge Company, Limited. The axles and springs will be made at Messrs. Cammell Laird's Sheffield works, and the tyres at Penistone.

By an arrangement involving the purchase of the shares, the control of International Processes, Limited, a company whose object is the introduction into this and other countries of new processes and inventions which have proved successful in the country of origin, is being acquired by Westminster Securities, Limited. The offices of International Processes, Limited, have been transferred to Westminster House, Great George Street, London, S.W.1, the headquarters of Westminster Securities, Limited.

Messrs. Lloyd, Withers & Pitt have commenced business as iron and steel merchants and stock holders at 15, Penn Street, Birmingham, with a London office at 14, Queen Victoria Street, E.C.4, where Mr. Pitt will be in charge. All three partners were formerly connected with Messrs. Adams & Benson, Limited, of West Bromwich, and previous to that Mr. W. D. Lloyd and Mr. H. G. Withers, were for many years associated with the well-known Birmingham firm of iron and steel merchants, Messrs. Sutton & Ash, Limited, of which company Mr. Lloyd was at the time a director.

The British Perlit Iron Company, Limited, of 15, Victoria Street, London, S.W.1, have negotiated licences for the manufacture of Lanz Perlit iron under the patents controlled by this company, to the following British companies:—Messrs. Clarke, Chapman & Company, Limited, Victoria Works, Gateshead-on-Tyne; Bellis & Morcom, Limited, Ledsam Street Works, Birmingham; Workman, Clark (1928), Limited, Belfast (on account of their Cyclops Foundry & Patternmaking Company, Limited, Whiteinch, Glasgow); and the Crown Agents for the Colonies on behalf of the Singapore Harbour Board, for the manufacture of Perlit and Emmel irons in Singapore.

Figures of the marine engineering output during 1928 of several North-East Coast firms are to hand. Marine geared turbines constructed by the Parsons Marine Steam Turbine Company, Limited, Wallsend-on-Tyne, during the year, totalled 155,600 shaft horsepower. The total s.h.p. of mechanical gearing manufactured by the firm, to be used in association with marine steam turbines, amounted to 138,000. In addition, the firm have cut gearing for their licensees during the year aggregating 82,500 s.h.p. The output of machinery for the year by Messrs. Richardsons, Westgarth & Company, Limited, of Hartlepool, Middlesbrough and Sunderland totalled 39,300 i.h.p. During the past year 28 vessels have been engined by the North-Eastern Marine Engineering Company, Limited, the total i.h.p. being 75,470.

Company Meetings.

Dorman Long & Company, Limited.—The ordinary general meeting was held in Middlesbrough recently. Sir Arthur J. Dorman, Bt. (chairman of directors), who presided, said that the year had not been an easy one. They started well with the remains of the accumulation brought about by the stoppage in 1926. Orders subsequently fell away, but there were now marked signs of improvement. Their bridge-building and constructional departments had been very busy. At the Middlesbrough constructional shop they had added another large bay. As a result their output had increased materially, and they were now busy for some months ahead. The sheet department had had another successful year. All the sheets were being rolled from their own steel. In Kent Messrs. Pearson and Dorman Long, Limited, were raising approximately 8,000 tons of coal per week at Snowdown Colliery. Arrangements were now being made to wind coal in the second shaft, and they hoped in the course of the next twelve months further to increase the output, and so to effect reductions in cost and make the colliery into a paying proposition. With regard to Betteshanger Colliery, they had been developing a seam at a depth of 2,400 ft., and were commencing to investigate another seam. They had, however, sunk in disturbed ground, and probably had another twelve months of investigation before them. The peculiar circumstances of Kent and the quality of the coal made it a very suitable place to adopt low-temperature carbonisation. An exhaustive examination of the various processes had induced Messrs. Pearson and Dorman Long, Limited, to adopt a process which was believed to be suitable for the quality of coal which occurred in that county. Plant for putting the process into operation was now being erected. Continuing, the chairman said that negotiations for amalgamation were taking place with Messrs. Bolckow, Vaughan & Company, Limited. The boards of both companies had given the whole question their most careful consideration, and had decided that the interests of both concerns would be advanced by amalgamation, if an equitable arrangement could be reached. It was impossible to make any detailed statement upon these negotiations until the two boards reached final agreement on a scheme which they considered could be laid before the shareholders of their respective companies.

Baldwins, Limited.—The annual general meeting was held recently in London. Colonel Sir W. Charles Wright, Bt. (the chairman), presided. The chairman stated that since the scheme of reconstruction received the sanction of the Court, on July 30 last, they had issued at 96½ per cent. the £1,000,000 6 per cent. debenture stock, which was over-subscribed in a very short space of time. The 4½ per cent. debenture stock had been repaid at par, and that day the balance of the 5 per cent. Port Talbot debenture stock would be repaid at 101 per cent. The companies to be merged—namely, the Port Talbot Steel Company, Limited, the Eagle Tinplate Company, Limited, British Steel Corporation, Limited, the Cornelly Quarry Company, Limited, the South Wales Concrete Brick Company, Limited, and the Black Mountain Silica Company, Limited—were going into voluntary liquidation that day with a view to being merged in the parent company. With regard to the immediate outlook, the coal position was still very serious, and the supply much in excess of the demand, with selling prices considerably below costs. In the tinplate and sheet trade their own works were in a comfortable position. They had difficulty in keeping their Landore steelworks fully going, but their Gowerton and Panteg works were working to capacity. The Port Talbot works had been working fairly fully, but, owing to the scarcity of shipbuilding orders, they found it very hard to keep all departments anything like fully running. As was stated at the last annual meeting, the board decided to dispose of the rolling-mill plant at Margam works to Australia, where they joined with the Hoskins Steel Company of Australia and Messrs. Dorman, Long & Company in the formation of Australian Iron and Steel, Limited. The dismantling and shipping of this material, they hoped, would be completed by February of next year. The coke-oven and by-product plant and one of the two blast furnaces were working fully and supplying hot metal to the Margam and Port Talbot steel furnaces. The melting shop at Margam was now partly taken up with the manufacture of special tube steel for the British Mannesmann Tube Company's requirements. The Elba Tinplate Company, which they put up jointly with the Anglo-Saxon Petroleum Company, was now satisfactorily running, and was of great help to the company in drawing from them its supplies of tinplate bars.

Personal.

Mr. A. P. Wood, managing director of the Lancashire Dynamo and Motor Company, Limited, Manchester, is benefitting in health from the complete rest he is taking and hopes to resume business activity again early in the New Year.

Wills.

Kitson, W., of Kirkstall, engineer	£429,129
George M'Kay Campbell, foundry manager, Singer Company, Kilbowie	£3,000
John Hastings, secretary, Falkirk Iron Company, Limited	£3,208
Robertson, M., of Glasgow, retired iron merchant	£34,780
Fagnani, H., formerly manager of the wire department of the London branch of the United States Steel Products Company	£9,329
Davies, M. F., of Manchester, a director of Messrs. Hicks, Hargreaves & Company, Limited, Soho Ironworks, Bolton	£32,042

Reports and Dividends.

Clayton & Shuttleworth, Limited.—Trading loss, £14,765; loss for year, £22,184.

Greenwood & Batley, Limited.—Interim dividend of 2½ per cent. on the ordinary shares.

Butterley Company, Limited.—The directors have decided to pass the second quarterly interim dividend.

North Lonsdale Iron and Steel Company, Limited.—Credit balance for year, after writing off £2,000 for depreciation, £4,121; brought in, £6,323; carried forward, £10,444.

Redpath, Brown & Company, Limited.—Profit, £114,321; brought in, £36,170; to depreciation reserve, £15,000; dividend of 16 per cent. and bonus of 6 per cent. on the ordinary shares, tax free; carried forward, £47,991.

New Companies.

Ealing Park Foundry, Limited, 57, Darwin Road, South Ealing, W.—Capital £12,000.

Aveling and Barford & Perkins (Sales), Limited, 70-71, Gracechurch Street, London, E.C.—Capital £10,000. Agricultural machinery manufacturers.

Verney Light Metals Company, Limited, 12, Verney Road, London, S.E.—Capital £3,000 in 4,000 preference shares of 5s. each and 2,000 ordinary shares of £1. Directors: J. A. Newton, H. E. Newton, H. J. Maybrey and G. W. Bacon.

L. N. Ledingham & Company, Limited, Napier Works, Leadmill Street, Sheffield.—Capital £3,000 in £1 shares (500 6 per cent. cumulative preference). Steel manufacturers, etc. Directors: L. N. Ledingham, F. E. Mount and H. Cahill.

English Steel Corporation, Limited.—Nominal capital £100 in £1 shares, to amalgamate certain departments of the undertakings, works, properties and assets of Vickers, Limited, Vickers-Armstrongs, Limited, and Cammell Laird & Company, Limited.

Contracts Open.

Birkenhead, January 5.—Cast-iron and/or steel pipes, with specials, for the Corporation. Mr. R. F. Baker, water engineer, 601, Borough Road, Birkenhead. (Fee £2 2s., returnable.)

Dungannon, January 2.—Supply and laying of 3,616 yds. of 8-in. steel water pipes and 2,250 yds. of 3-in. cast-iron water main, for the Dungannon Joint Committee. Mr. W. J. Beatty, secretary, Market Square, Dungannon. (Fee £1, returnable.)

Johannesburg, January 31.—Pig-iron and ferro-manganese, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7273.)

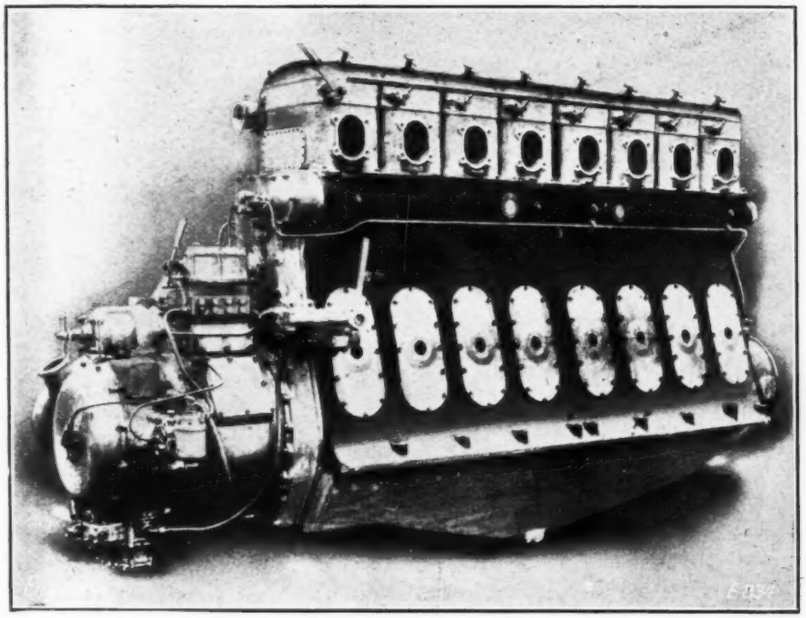
London, S.W., January 1.—Non-ferrous metals, for the Madras and Southern Mahratta Railway Company, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee £1 1s., non-returnable.)

Sandwich, December 31.—Supplying and laying about 200 yds. of 3-in. diam. cast-iron water mains, hydrants, etc., for the Corporation. Mr. W. R. Moultrie, acting waterworks manager, The Barbican, Sandwich. (Fee £2, returnable.)

Rhyl, January 7.—Supply and erection of oil engine and centrifugal pump, etc., for the Rhyl Urban District Council. Mr. O. P. Cronshaw, water engineer, Paradise Street, Rhyl. (Fee £1 1s., returnable.)

The death took place last Sunday of Mrs. H. Faulkner, wife of Mr. V. C. Faulkner, a past-president of the Institute of British Foundrymen.

F.T.J 29.12.28



650 *H.P. 8-Cylinder Heavy Oil Engine for Airship Work.*
(Wm. Beardmore & Co., Ltd.)

*The crankcase is of the monobloc type, and, when a steel casting is used, the weight of the engine is ..... 4,600 lbs.

and with aluminium crankcase ..... 3,600 lbs.

* *Vide* A. E. L. Chorlton, Esq., British Association, Sept. 10, 1923.

1,000 lbs. lighter with Aluminium

THE BRITISH ALUMINIUM CO., LTD., Aluminium Producers, Adelaide House, King William Street, LONDON, E.C.4

WARNER'S CYLINDER PIG IRON

THE WORLD'S BEST

BRAND "WARNER C.D.R."

As supplied to the leading.... RAILWAY COMPANIES, LOCOMOTIVE, DIESEL and OIL ENGINE BUILDERS.
Also unequalled for AUTOMOBILE CYLINDER BLOCKS, COMPRESSORS, ENGINEERS' TOUGH CASTINGS and CHILLED ROLLS.

WARNER & CO. LTD.
CARGO FLEET, MIDDLESBROUGH ON TEES.

ALSO MAKERS OF HIGH CLASS REFINED PIG IRON IN SMALL PIGS, FOR ALL KINDS OF MALLEABLE CASTINGS

TELEGRAMS: REFINERY MIDDLESBROUGH.

TELEPHONE: MIDDLESBROUGH 4265.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Retrospective reflections upon the conditions of trade in the Cleveland iron industry during the twelve months now drawing to a close would hardly be pleasant reading for the festive season, and, as limits of space available are severely restricted, it must be sufficient to add that the year 1928 will long figure in the records of Teeside as one of the most depressing and disappointing in the annals of its history. It will be perhaps more to a useful purpose to survey the prospects of the pig-iron trade, so far as at present disclosed, for the coming year, and the influences at work for the betterment of business generally now more convincingly apparent. First, it may be submitted that signs of increasing activity in the great basic industries, shipbuilding, engineering, foundry and other consumptive branches, are already in evidence, and even the Prime Minister himself has admitted:—"We may reasonably look forward, without undue optimism, to a general expansion of trade in the country." The current week has of course, been almost entirely devoted to holiday-making, markets being practically closed everywhere until the New Year, which, it is most earnestly desired on all hands, may inaugurate a new era of prosperity for the many and varied consuming interests represented in THE FOUNDRY TRADE JOURNAL. In the meantime there will be no alteration of prices, which remain as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 Cleveland G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge iron, 64s. 6d. per ton.

In the East Coast hematite section very little business will be done until early in the New Year, and prices remain stationary at the old levels:—71s. per ton for mixed numbers and 71s. 6d. for No. 1. On the North-West Coast Bessemer mixed numbers are still quoted at 71s. per ton at works.

LANCASHIRE.—Pig-iron values have undergone no change during the holidays. For delivery Manchester or equal distance Midland brands of foundry iron are at 67s. 6d. per ton for Derbyshire and from 67s. to 67s. 6d. for Staffordshire.

THE MIDLANDS.—At Birmingham there has been no material change in prices. Northampton No. 3 is quoted at 55s. to 56s. 6d., Derbyshire from 59s. to 60s., and Staffordshire at 60s. f.o.t. furnaces.

SCOTLAND.—At Glasgow quotations for foundry pig-iron are unchanged, but with the considerably reduced make, smelters are inclined to talk of firmer prices, although, so far, they are having difficulty in raising prices to a higher level.

Metals.

Copper.—The markets for base metals generally remain steady and firm, warrant copper reaching the £70 per ton level a week ago, and is still expected to further appreciate at the resumption of active business. The American statistics for last month show that for the first time since last March production has actually exceeded deliveries by about 6,000 tons, so that there has been no undue haste in the expansion of output.

Closing quotations are:—

Cash.—Thursday, £69 11s. 3d. to £69 12s. 6d.; Friday, £70 6s. 3d. to £70 7s. 6d.; Monday, £70 12s. 6d. to £70 15s.

Three Months.—Thursday, £69 to £69 1s. 3d.; Friday, £69 10s. to £69 11s. 3d.; Monday, £69 11s. 3d. to £59 12s. 6d.

Tin.—Fluctuations in tin values of late have had an erratic tendency, consumers apparently having lost all confidence after the recent heavy slump in values, and it will require a large amount of support from the "Group" before any feeling of stability is restored. The renewed buying of spot and the further lifting of warrants seem to indicate that all attempts to regain the control of the market have not been abandoned. American advices state that some business has passed there and that consumers are covered well ahead.

Official closing prices:—

Cash.—Thursday, £223 12s. 6d. to £223 17s. 6d.; Friday, £222 17s. 6d. to £223; Monday, £224.

Three Months.—Thursday, £223 to £223 5s.; Friday, £223 to £223 5s.; Monday, £224 to £224 5s.

Spelter.—A fair amount of business has been done with consumers lately, some demand having been stimulated by the result of the producers' meeting in Brussels recently. But reports of the precise nature of the intended curtailment are very vague.

Daily quotations are:—

Ordinary.—Thursday, £26 13s. 9d.; Friday, £26 15s.; Monday, £26 12s. 9d.

Lead.—The market for soft foreign pig offers little fresh ground for comment, the basic position having changed hardly at all. Business with consumers is on the dull side, but, despite the heavy arrivals of metal, a confident feeling seems to pervade the market.

Prices have been:—

Soft Foreign (Prompt).—Thursday, £21 6s. 3d.; Friday, £21 3s. 9d.; Monday, £21 3s. 9d.

A Foundry Owner's Christmas Charity Fund.

Mr. J. Hepworth, of Hepworth & Grandage, Limited, St. John's Foundry, Bradford (the foundry manager of which is Mr. S. W. Wise, Hon. Secretary of the West Yorkshire Branch of the Institute of British Foundrymen), is conducting his usual active campaign for the collection of old or new toys to be distributed to the poor children of Bradford for Christmas. This is an effort in which Mr. Hepworth takes a very successful lead each Christmastime, and which has brought joy to many a youngster who would otherwise have little or none of all that Christmas means to kiddies.

MESSRS. GILLESPIES, LIMITED, Chattan Stove and Iron Works, Bonnybridge, have decided to go into voluntary liquidation.

European Steel Syndicates.

As was expected, the group representatives in the Continental Steel Trust, at the recent meeting in Paris, decided to leave the total production in the first quarter of next year at the present annual rate of 29,278,000 tons. A proposal made by the French group that the total annual tonnage should be increased by 1,000,000 tons, failed to find the support of the other members, and was consequently rejected. The question of compensation for the short production of the German works owing to the lock-out was postponed for future consideration, as was also the suggestion that the independent German output should be distributed over the various national groups. The next meeting of the Trust is to be held on March 14.

Concerning the European Rail Manufacturers' Association (Erma), it is stated that an understanding at the recent Paris meeting was not reached with regard to the penalty to be paid into the common fund by the British members on account of their continual sales in excess of their allotments in the Association. The tone of the discussions on that occasion leads to the expectation that the matter will be definitely settled at the next meeting. The question of the prolongation of the Association, whose present agreement nominally expires on March 31, has not yet been discussed. It is, however, anticipated that the Erma will be extended.

The European Tube Syndicate, which is composed of German, French, Belgian, Czechoslovak, Hungarian and Polish works, is reported to have at last reached an understanding with the British tube makers, who had claimed that the British Dominions should be considered as part of their inland market. This event is regarded as being of special importance to the international tube market, as an understanding has been come to with the American tube works also. The arrangement between the Syndicate and the British and American works takes the form of a price understanding, which is to continue until the end of February, in relation to the whole of the world markets. In the meantime negotiations will be proceeding with a view to bringing about a still closer connection between the Syndicate and the other two countries. A general increase in the prices of gas tubes has been decided upon. The German Tube Syndicate confirms the statement that the negotiations recently conducted at Düsseldorf have led to a provisional agreement with the British works.

Obituary.

MR. JOHN PRIEST, of Halesowen, died recently at the age of sixty-eight. He joined his father, the late Mr. Benjamin Priest, in business as nail, chain and rivet manufacturers, retiring in 1916.

MR. SYDNEY J. ROBINSON, whose death has occurred, aged 70, was intimately associated with the Sheffield steel trade. He was a former Master Cutler, a past-President of the Sheffield Chamber of Commerce and a member of the Iron and Steel Institute.

Coated Castings.—Carbon or alloy steel castings with a coating of ferro-chrome are now being made by the Bethlehem Steel Company, Bethlehem, Pa., U.S.A. The coating forms an integral part of the castings, covering only those surfaces which are exposed to heat or acids or wear. The coating is hard and tough, and cannot be chipped off or separated by mechanical means.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & CO., LTD.
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Sterling

ALL STEEL TUBULAR

WHEELBARROWS

ARE IDEAL FOR ALL FOUNDRY PURPOSES.

THEY POSSESS MANY IMPORTANT ADVANTAGES.

Tray set well forward.
The load is on the Wheel.

Tray Reinforced with Stout Continuous Rod.

Broad Tyred 10-spoke Wheel.

Substantial Nose for forward dumping.

Strong Tubular Handles.

Patent Clip avoids perforating the Handle at point of strain.

Legs strongly braced cannot get shaky.

Pre-lubricated Axle-bearings. Never require oiling.

Legs bent square and fitted with renewable Shoes.

A Sterling Product designed for hard work and built to last.

All parts are standardised and interchangeable for repairs.

Capacities from 2½ to 6 cubic feet.

Write for Catalogue No 37.

STERLING FOUNDRY SPECIALTIES LTD.

London Office :
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone : 3345 BEDFORD.
Telegrams : "STERFLASK, BEDFORD."
Code : WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	70 12 6
Three months	69 11 3
Electrolytic	74 15 0
Tough	73 0 0
Best selected	73 10 0
Sheets	98 0 0
India	83 0 0
Wire bars	75 2 6
Do. December	75 2 6
Do. January	75 2 6
Ingot bars	75 2 6
H.C. Wire rods	79 5 0
Off. av. cash, November	68 2 3 5/11
Do. 3 mths., November	68 10 11 3/11
Do., Sttlmnt., November	68 2 4 1/11
Do., Electro, November	74 19 7 10/11
Do., B.S., November	73 1 4 5/11
Aver. spot price, copper, Nov.	68 2 3 9/11
Do. Wire bars, November	75 4 3 9/11
Solid drawn tubes	13¾d.
Brazed tubes	13¾d.
Wire	10¼d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11¾d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	10¼d
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

Standard cash	224 0 0
Three months	224 0 0
English	224 0 0
Bars	225 0 0
Straits	224 0 0
Australian	224 0 0
Eastern	225 10 0
Banca	224 7 6
Off. av. cash, November	232 19 5 5/11
Do., 3 mths., November	228 0 11 3/11
Do., Sttlmt., November	232 18 11 9/11
Aver. spot, November	232 19 5 5/11

SPELTER.

Ordinary	26 12 9
Remelted	24 15 0
Hard	20 0 0
Electro 99.9	29 5 0
English	27 0 0
India	20 0 0
Zinc dust	(Nom.) 36 10 0
Zinc ashes	8 5 0
Off. aver., November	24 16 3 1/11
Aver., spot, November	24 16 0 5/11

LEAD.

Soft foreign ppt.	21 3 9
English	22 10 0
Off. average, November	21 7 0 2/11
Average spot, November	21 4 9 5/11

ZINC SHEETS, &c.

Zinc sheets, English	35 0 0
Do. V.M. ex whf.	33 10 0
Rods	43 0 0
Boiler plates	32 0 0
Battery plates	33 0 0

ANTIMONY.

Special brands, Eng.	54 10 0
Chinese	38 15 0
Crude	33 10 0

QUICKSILVER.

Quicksilver	22 5 9

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	7 17 6
45/50%	12 0 0
75%	19 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/5 lb.
Tungsten metal powder—	
98/99%	1/10 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 12 6
6/8% car.	£20 12 6
8/10% car.	£20 7 6
Ferro-chrome—	
Max. 2% car.	£33 2 6
Max. 1% car.	£37 0 0
Max. 0.70% car.	£44 0 0
70% carbonless	1/- lb.
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98 99%	£95 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80% export	£14 10 0
Metallic manganese—	
94/96% carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—
- Rounds and squares, 3 in. and over — 4d. lb.
- Rounds and squares, under ½ in. to ¼ in. — 3d. lb.
- Do., under ¼ in. to 1/8 in. — 1/- lb.
- Flats, ½ in. × ¼ in. to under 1 in. × ¼ in. — 3d. lb.
- Do., under ½ in. × ¼ in. — 1/- lb.
- Bevels of approved sizes and sections — 6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—
- Scrap pieces — 3d.
- Turnings and swarf — 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 8 6	
Bundled steel and shrngs.	3 4 0	to 3 8 0
Mixed iron and steel	3 2 6	to 3 4 0
Heavy cast iron	2 16 0	to 2 18 0
Good machinery for foundries	2 18 0	to 3 0 0
Cleveland—		
Heavy steel	3 0 0	
Steel turnings	2 8 0	
Cast iron borings	2 3 0	
Heavy forge	3 7 6	
Bushelled scrap	2 18 6	
Cast-iron scrap	3 2 6	
Lancashire—		
Cast-iron scrap	2 15 0	to 3 5 0
Hvy. wrought	3 7 6	
Steel turnings	2 5 0	

London—Merchants' buying prices delivered yard.

Copper (clean)	54 0 0
Brass	39 0 0
Lead (less usual draft)	19 0 0
Tea lead	16 0 0
Zinc	15 10 0
New aluminium cuttings	65 0 0
Braziery copper	50 0 0
Gunmetal	50 0 0
Hollow pewter	150 0 0
Shaped black pewter	105 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	71/6
Hematite M/Nos.	71/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/-
,, d/d Birm.	85/6
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—

* d/d Birmingham.

Northants forge	52/6
,, fdry. No. 3	55/-
Derbyshire forge	59/-
,, fdry. No. 3	60/-
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	75/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	63/-
Lincs. forge	62/6
,, fdry. No. 3	64/6
E.C. hematite	81/-
W.C. hematite	82/6
Lincs. (at furnaces)—	
Forge No. 4	58/-
Foundry No. 3	60/-
Basic	60/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	67/6
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartsherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.		10 5 0
Nut and bolt iron	8 12 6	to 8 17 6
Hoops		11 10 0
Marked bars (Staffs.) f.o.t.		12 0 0
Gas strip		11 10 0
Bolts and nuts, ¾ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 7 6	to 8 12 6
Boiler plts.		10 10 0
Chequer plts.		10 12 6
Angles		7 17 6
Tees		8 17 6
Joists		7 17 6
Rounds and squares, 3 in. to 5½ in.		8 17 6
Rounds under 3 in. to ¾ in. (Untested)		7 15 0 and upwards
Flats, over 5 in. wide and up		8 7 6
Flats, 5 in. to 1¼ in.		7 17 6
Rails, heavy		8 10 0
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g.	10 0 0	to 11 0 0
Galv. cor. shts. 24g.	13 7 6	to 13 12 6
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	6 5 0	to 6 12 6
Billets, hard	7 0 0	to 7 12 6
Sheet bars		6 0 0
Tin bars		6 0 0

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 2½
Sheet to 10 w.g.	1 3½
Wire	1 4½
Rods	1 3½
Tubes	1 7½
Castings	1 2½

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	16.50
Basic	19.26
Bessemer	20.79
Malleable	20.01
Grey forge	19.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, 9 and 10	2.10
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.25

COKE (at ovens)

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	16/-
,, furnace	14/-
Midlands, foundry	—
,, ,, furnace	13/- to 14/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/-
,,	28×20 ,,	36/-
,,	20×10 ,,	26/3
,,	18¾×14 ,,	18/9
C.W.	20×14 ,,	15/-
,,	28×20 ,,	33/6
,,	20×10 ,,	21/-
,,	18¾×14 ,,	15/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars & nailrods, rolled, basis	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars & rods, dead soft, steel	£10 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	50%
Water	63¾%	45%
Steam	60%	40%

W.I. 10% extra.

Electrolytic Copper.

	£ s. d.	
Dec. 20 ..	74 15 0	No change
,, 21 ..	74 15 0	,, ,,
,, 24 ..	74 15 0	,, ,,

Tin (English ingots).

	£ s. d.	
Dec. 20 ..	223 10 6	No change
,, 21 ..	223 0 0	dec. 10/-
,, 24 ..	224 0 0	inc. 20/-

Spelter (ordinary).

	£ s. d.	
Dec. 20 ..	26 13 9	dec. 1/3
,, 21 ..	26 15 0	inc. 1/3
,, 24 ..	26 12 9	dec. 2/3

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Dec. 20 ..	69 11 3	dec. 13/9
,, 21 ..	70 6 3	inc. 15/-
,, 24 ..	70 12 6	,, 6/3

Standard Tin (cash).

	£ s. d.	
Dec. 20 ..	223 12 6	dec 12/6
,, 21 ..	222 17 6	,, 15/-
,, 24 ..	224 0 0	inc 22/6

Zinc Sheets (English).

	£ s. d.	
Dec. 20 ..	35 0 0	No change
,, 21 ..	35 0 0	,, ,,
,, 24 ..	35 0 0	,, ,,

Lead (English).

	£ s. d.	
Dec. 20 ..	22 10 0	No change
,, 21 ..	22 10 0	,, ,,
,, 24 ..	22 10 0	,, ,,

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1887	37 5	35 10	34 4	34 4	34 1	34 10	34 4	34 5	33 9	31 10	31 8	33 6	34 2
1888	32 2	31 1	31 5	31 9	30 11	31 5	32 4	33 5	34 8	34 2	33 11	33 10	32 7
1889	33 8	35 0	37 5	38 9	38 6	37 10	40 1	43 4	44 1	51 5	64 7	61 1	43 10
1890	60 3	53 1	51 0	47 4	42 2	41 5	43 2	45 7	47 9	47 10	47 4	43 1	47 6
1891	42 1	41 10	39 9	38 7	40 9	41 0	40 8	39 8	40 4	39 11	38 8	38 1	40 1
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 6	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	52 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	48 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	91 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARKS

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

METALLURGIST, capable of taking complete control of grey iron and non-ferrous foundries, desires change; exceptional experience in the production of steel mix and alloy grey iron castings for high pressure work; University graduate, with thorough practical training.—Full particulars on application to Box 930, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

STOREKEEPER AND PACKER required for Foundry at Richmond; an energetic man with previous engineering experience essential.—Write full particulars and wages required to Box 936, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN PATTERNMAKER wanted for Steel Foundry (N.E. Coast); must be thoroughly accurate and reliable, capable of producing patterns cheaply; state wages required.—Apply, Box 934, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

11 ACRES WORKS SITE, SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,
Compact and Convenient.
SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.
WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers, or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

FREEHOLD BUILDINGS AND OFFICES covering 13,000 sq. ft., adjoining Station.—GIRLINGS, Maldon, Essex.

PATENTS AND TRADE MARKS.

INFORMATION HANDBOOKS, Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146A, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

PATENTS AND TRADE MARKS.—*contd.*

THE Proprietors of the Patent No. 137,574 for Improvements in Steel Smelting Furnaces are desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to HASELTINE, LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

THE Owner of British Patent No. 247,683 and Patent of Addition No. 249,313, relating to "A Machine or Apparatus for Treating or Preparing Moulding-sand and for Analogous uses," is desirous of entering into negotiations for the grant of licences or otherwise, under reasonable terms, for the purpose of exploiting the invention and ensuring its full development and practicable working in this country.—For particulars address ARTHUR SADLER, 44, Waterloo Street, Birmingham.

SALE BY PRIVATE TREATY.

TRAFFORD PARK, MANCHESTER.

For Sale by Private Treaty at a bargain price.

MODERN FOUNDRY—ERECTED 1921, with Railway Sidings into Works. Excellent Warehouse and Packing Room and fine Suite of Offices. Area of land 7,173 sq. yds., of which 2,850 are covered by a one-storey erection on same level. Easily adaptable for other trades.

To treat: F. S. AIREY, ENTWISTLE & COMPANY, 10, Norfolk Street, Manchester.

MACHINERY.

WANTED, good secondhand Moulding Machines, for rapid production of repetition castings.—Box 932, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Second-hand Moulding Machine, to take 14-in. square boxes, Samuelson's, or similar over-head, hand-power type.—Box 938, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS AND CORE-MAKING MACHINES.—Ask for our quotation for new Machines; prices from £14 upwards. Write for List.

SULRON, LIMITED,
FOUNDRY ENGINEERS,
CLOISTER WORKS,
CONGRESS STREET, SHEFFIELD.

Write to-day for our No. 1 Foundry Bulletin. Sent free on request.

MACHINERY.—*Continued.*

New 9-in. centres Combination Turret Lathe on 8 ft. 3 in. bed, all geared, S.P.D.

New 7 in. centres Combination Turret Lathe on 6 ft. 6 in bed, all geared, S.P.D.

New Capstan Lathes, 1 in. and 2 in. holes through spindles; bargains.

New 8 in. centres Relieving Lathe on 4 ft. 3 in. bed.

Two 20-h.p. "Simplex" PETROL LOCOMOTIVES (Motor Rail and Tramcar Co.), 2-ft. gauge, two cylinder "Dorman" Engine.

One 40-h.p. "Simplex" PETROL LOCOMOTIVE (Motor Rail and Tramcar Co.), 2-ft. gauge, four cylinder "Dorman" Engine.

50-ton "Denison" TRUCK WEIGHBRIDGE, platform 16 ft. x 8 ft., 4-ft. 8½-in. gauge rails, no-loose-weight steelyard.

Two 40-ton "POOLEY" TRUCK WEIGHBRIDGES, platforms 22 ft. x 6 ft., 4-ft. 8½-in. gauge, no-loose-weight steelyard.

Two LANCASHIRE BOILERS, 30 ft. x 8 ft., reinsure 110 lbs. pressure.

A number of open-top Wrought Iron or Steel Cisterns, each 3 ft. x 8 ft. x 8 ft. deep x about 3/16 in. thick, capacity about 3,200 gallons each

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

'Phone: 287 SLOUGH.

MOULDING MACHINES

ONE 18"×18" Tabor Split pattern .. **£70**
Two 40"×30" Tabor Shockless rollover **£160** each
12" Shockless plain jolter, 72"×60" table **£140**
Two Bonvillain machines (24" dia. boxes) **£120**
Four No. 0 Britannia jolters .. .. **£20** each
One 24"×48" Tabor Shockless rollover **£140**
One 18"×36" Tabor Shockless rollover **£110**
Twelve Adaptable Moulding Machines **£16** each

ALL ABOVE IN PERFECT ORDER.

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH.

"NONACIL" Black Enamel Paint

Whether the Buildings round your Foundry are showing Signs of Corrosion or not "NONACIL" sparsely applied will prolong their life enormously—The Finished Effect is Most Pleasing—and with its High Covering Factor the Prices are Undoubtedly Economic.

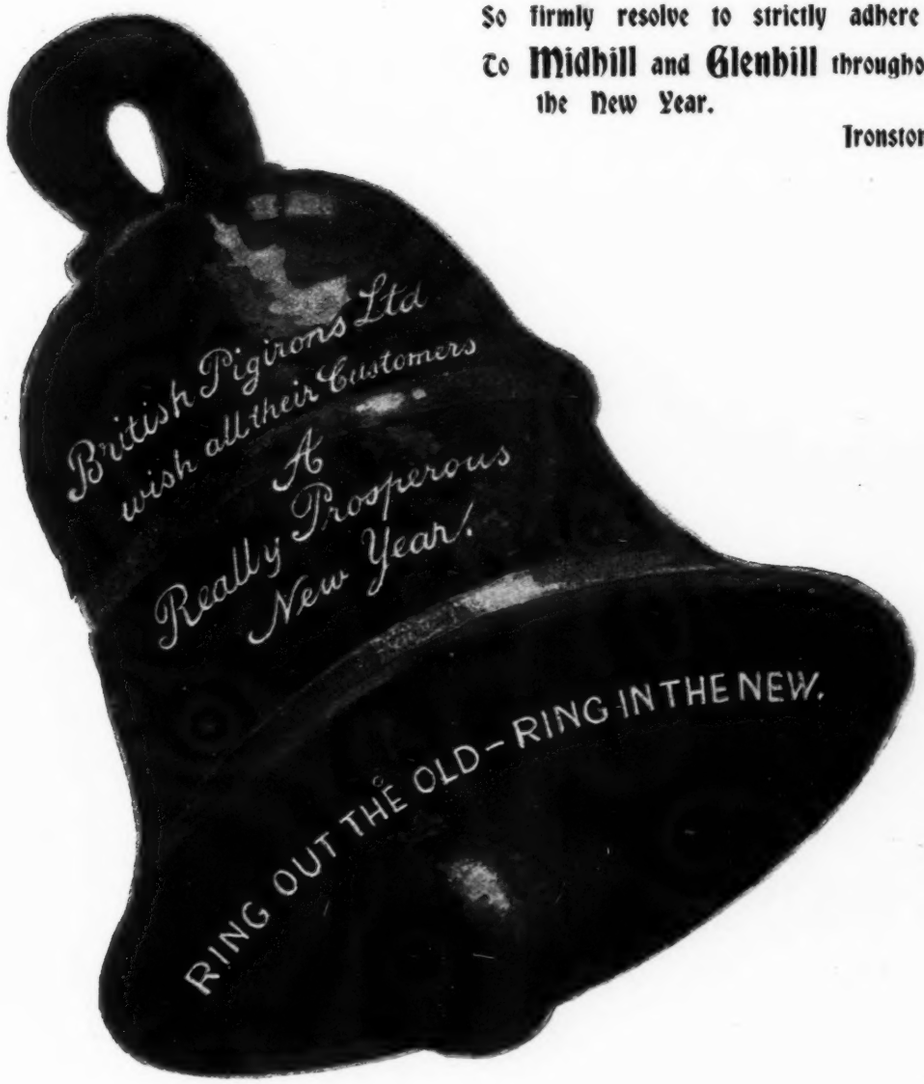
PLEASE WRITE TO:

PEASE & PARTNERS, LTD. - DARLINGTON

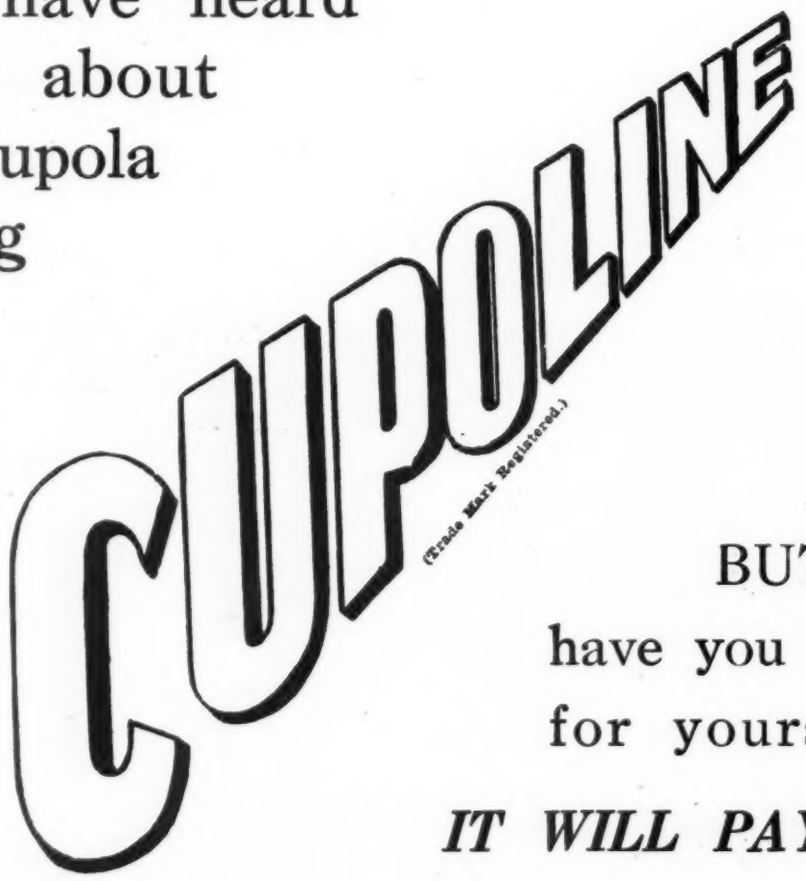
Telephone: 2630 Darlington. *Telegrams: "Pease, Darlington."*

Midhill and **Glenhill**, as Founders
will tell,
Are noted for Castings as sound as
a bell.
It is safer and wiser to stick to a
brand,
Whose good reputation exists o'er the
land.
So firmly resolve to strictly adhere
To **Midhill** and **Glenhill** throughout
the New Year.

Ironstone.



You have heard
a lot about
the Cupola
Lining



BUT
have you tried it
for yourselves?

IT WILL PAY YOU.

ROBSON REFRACTORIES Ltd.

16, North Road,

DARLINGTON, Durham.

Telephone : 2405. *Telegrams : Cupoline, Darlington.*

CUPOLINE STORAGE DEPOTS AT:

Middlesbrough, Leith, Newcastle-on-Tyne, Newport (Mon.), Garston, Liverpool and London.

Makers of The Osborn Patent Cupola Spark Arrester

Advantages :

Immunity from Sparks and Grit.

Avoids damage to Roofs, choking up of Gutters.

Prevents danger of Fire.

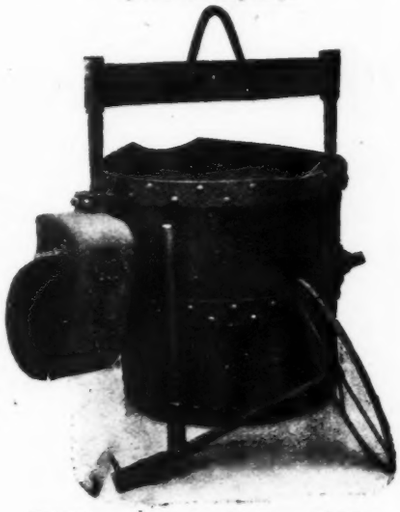
Important Labour Saver.

Conducts all Grit and Dust down to, or through the Charging Platform, where they can be dropped into a cart without handling.

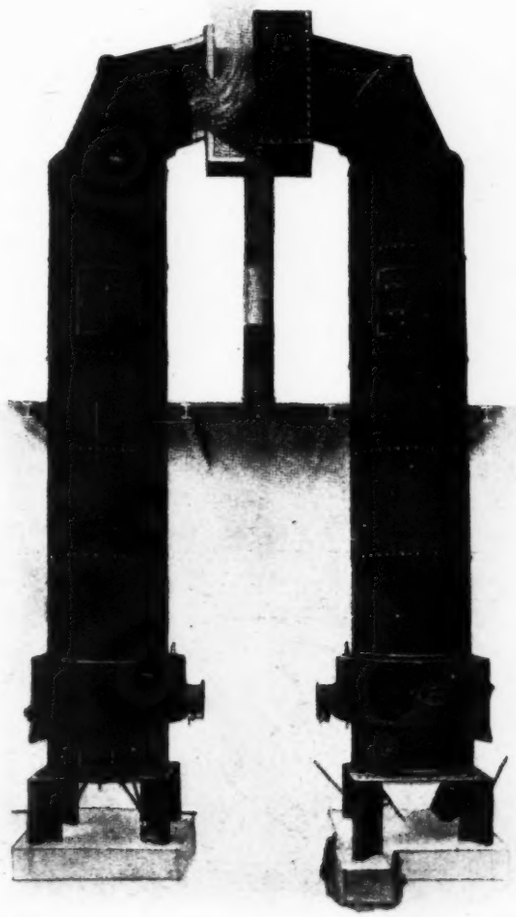
Constructed in sections to facilitate erection.

Can be fitted to existing Cupolas.

This illustration represents Geared Ladles up to 2 tons capacity.



This illustration represents Geared Ladles from 2½ to 10 tons capacity, fitted with oil-tight gear cover.



Two Drop Bottom Rapid Cupolas, and Duplex Osborn Patent Spark Arrester, with down-take tube to conduct the dust down to, or through the charging platform.

T. DAVIES & SON

RAILWAY IRONWORKS,

WEST GORTON :: :: MANCHESTER

Also Makers of

FOUNDRY CUPOLAS AND LADLES

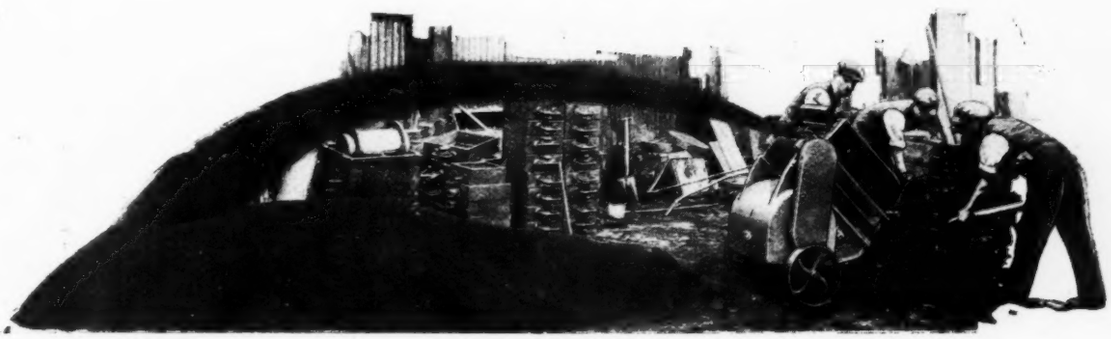
Telegrams—"TUYERE, MANCHESTER." ON ADMIRALTY LIST. *Telephone No.*—70 OPENSHAW.

GOLDENDALE
THE HIGHEST STANDARD
CYLINDER PIG IRON
DENSE GREY FRACTURE.
UNRIVALLED FOR CLEANLINESS AND FLUIDITY.
EXCELLENT MACHINING QUALITIES.
SUITABLE FOR—
STEAM, HYDRAULIC, GAS & OIL ENGINES AND HIGH CLASS ELECTRICAL CASTINGS.
SPECIAL QUALITY
FOR AUTOMOBILES & AERO ENGINES.
"USED THE WORLD OVER"
Selected Fractured and Supplied to Analysis
Contractors to:—
The Admiralty, War Office, Home and Colonial Governments and Railways.
Sole Agents —
WESTOBY & RAWSTRON
326 & 327, ROYAL EXCHANGE, MANCHESTER.
TELEGRAMS:—"RAWSTRON". TELEPHONE:—CITY 1405.

over twelve tons of sand per hour conditioned with a No. 2 size PNEULEC ROYER

There is one firm who bought their first Pneulec Royer two years ago, and who now have ten machines in use. Repeat orders of this kind call for no further comment.

This machine is fitted with a 2 h.p. motor and consumes 1.25 h.p. under full load

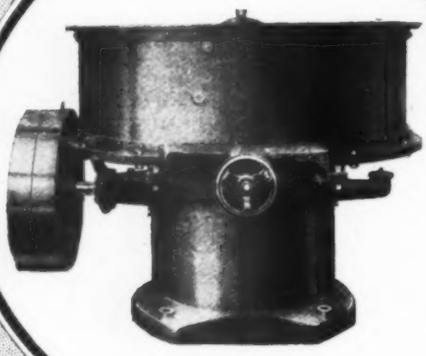


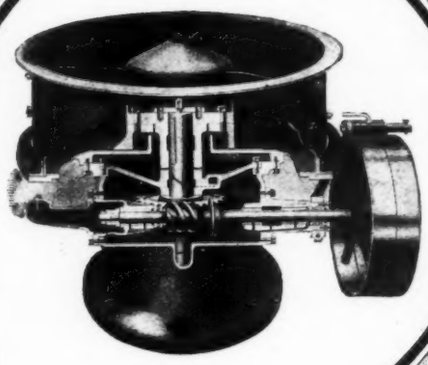
The method of operation makes the Pneulec Royer so adaptable that its application is quite unlimited. The list of users shows this and also indicates that there is hardly a single class of casting which the Pneulec Royer is not helping produce better and cheaper. You will find both big repetition foundries and small jobbing shops using the machine, and each will tell you that they find the Pneulec Royer of real assistance.

It is significant that the majority of the machines sold during 1928 were sold as a result of the recommendation of one firm to another. If you are in any doubt as to the suitability of the Pneulec Royer for any particular duty, ask for one of our representatives to call and see you. Each of these men have used Pneulec Royers under all sorts of conditions, and can tell you definitely as to whether the machine will help you.

PNEULEC

PNEULEC LIMITED ~ Mafeking Road. Smethwick ~ Nr BIRMINGHAM





The ROTOIL SAND MIXER

CORE SANDS.

The total time for a complete operation involving 4 CWTS. of mixture, is 4 MINUTES, including filling and discharging, or 3 TONS PER HOUR.

MOULDING SANDS.

MIXED IN A "ROTOIL" the strength INCREASE is 100 per cent., the permeability "INCREASE" is 45 per cent.

(N.B.—MIXED IN A MILL the strength INCREASE is 160 per cent., the permeability "DECREASE" is 700 per cent.)

The squeezing pressure exerted in a "ROTOIL" is 40 lbs. per sq. in.

The only attention required by a "ROTOIL" which has been running 20 hours per working day for 9 months, has been the addition of a little lubricating oil weekly.

The machine works noiselessly.

The capital cost of a "ROTOIL" based on a 10 years' life, is 1/- per working day.

The saving in labour is far in excess of the initial cost.

In efficiency, the "ROTOIL" is unequalled.

GLYCO CORE OIL COMPOUNDS

GLYCO CORE OIL COMPOUNDS

The FORDATH ENGINEERING Co

TELEPHONE W. BROMWICH 549

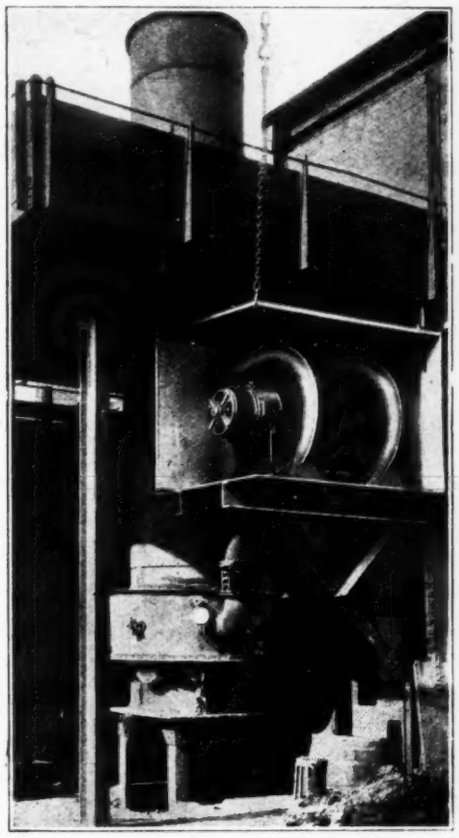
HAMBLET WKS. WEST BROMWICH

TELEGRAMS "METALLICAL."

The most efficient BLAST EQUIPMENT for CUPOLAS!

Keith-Blackman CUPOLA FANS

They bring down more metal per hour for less power! —Ensure uniform reduction of metal!—Give longer life to the cupola linings!—Can be relied on to give efficient service under severe conditions!



We shall be pleased to send you full particulars and to refer you to users in your neighbourhood.

BLACKMAN AIR PROPELLER

TRADE MARK

JAMES KEITH & BLACKMAN CO LTD

Engineers and Manufacturers of Fans for all Foundry Trade purposes.

27, Farringdon Avenue, London, E.C.4.

Telephone: Central 7091-7096. Telegrams: "James Keith, Phone, London."

— IMPORTANT NOTICE —

We have discovered that there is an impression existing that we only make Air Compressors for use with our Sand Blast Plants . . .

THIS IS QUITE WRONG.

We have been making Air Compressors of all Types and Sizes up to 3,000 Cubic Feet Capacity FOR 40 YEARS

Thousands of our machines are at work for all purposes—quite apart from those supplied with our Sand Blast machinery.

Let us know your compressor requirements. We can supply just the machine you want.

TILGHMAN'S PATENT SAND BLAST CO., LTD.

BROADHEATH, near MANCHESTER

Telephone: 540, 541 *and* 542 *Altrincham.*

Telegrams: *Tilghmans, Altrincham.*

London Office: 17 Grosvenor Gardens, S.W.1.

H.D.

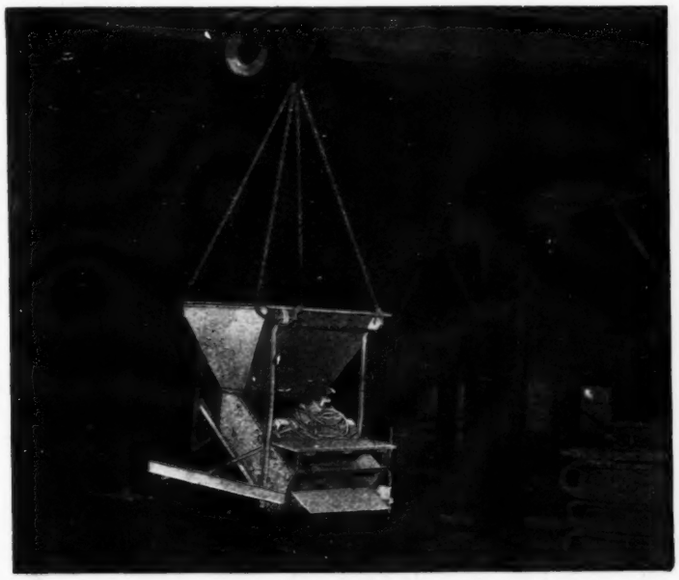
ARMSTRONG WHITWORTH

Enquiries Invited for all types of Pneumatic Tools

Sir W. G. Armstrong Whitworth & Co., Ltd.
Sales Organisation:
Kinnaird House, Pall Mall East, S.W.1.
Works and Shipyards - - Newcastle-upon-Tyne.

PNEUMATIC TOOLS

M.O. 925.



Removes Dust from Raw Foundry Sand

The HUM-MER *Electric* SCREEN thoroughly and effectively removes the dust which causes blowholes by packing in the crevices between the grains of sand.

Sand screened by the HUM-MER has a maximum permeability—gases formed by the union of molten metal and materials on the face of the mould being given every opportunity to escape.

BRITISH BUILT

INTERNATIONAL COMBUSTION LTD

GRINDING & PULVERIZING OFFICES
11, Southampton Row, London, W.C.1.

Telephone- Holborn 7277-8. Cable & Telegraphic Address -"Zopulco, Westcent, London."

WORKS: - DERBY - ERITH.

HUM-MER *Electric* SCREENS

for greater success in— CASTINGS USE

THE ONE AND ONLY

"BALTISEED" (REGD.) CORE OIL

also

CORE CREAM AND CORE COMPOUNDS

(SEMI SOLIDS)

FOR IRON & STEEL CASTINGS.

Now in use in the largest Foundries in the country.

Being a Standard Quality Every Barrel is Guaranteed

Tel : HALIFAX 3308.

For particulars write :—

WM. ASKE & CO., LIMITED. SOLE MANUFACTURERS,

VICTORIA OIL WORKS, HALIFAX.

ESTABLISHED OVER 30 YEARS.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office : 37 RENFIELD STREET, GLASGOW.
Works : HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address : "Steel, Glasgow."*

ALLDAYS & ONIONS LTD.

ROOTS BLOWERS
CUPOLAS
CHARGING MACHINES
LADLES

FANS FOR ALL PURPOSES
SAND MILLS
FURNACES
HAMMERS STEAM & PNEUMATIC

GREAT WESTERN WORKS, BIRMINGHAM

9, VICTORIA STREET, LONDON, S.W.1

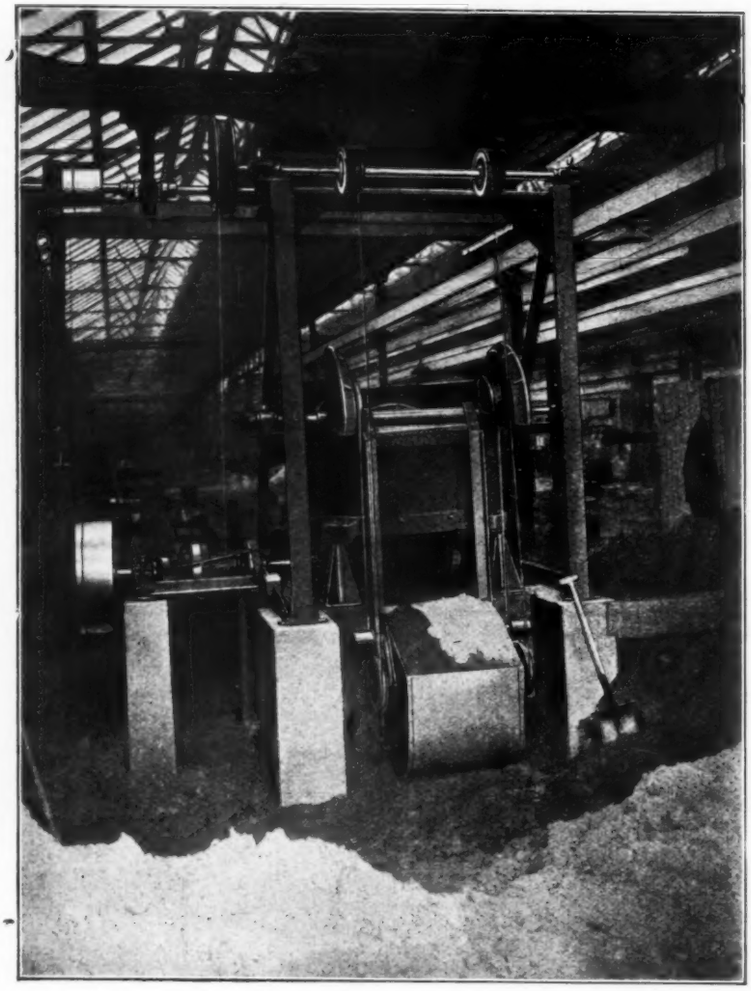
INDEX TO ADVERTISERS.

	PAGE
Abbott, J. C., & Co., Ltd.	—
Acheson, E. G., Ltd.	22
A. E. B. Products	21
Alldays & Onions, Ltd.	13
Allen, T. Fearnley, & Son	—
Amalgams, The, Co., Ltd.	—
Armitage Works Co., Ltd.	—
Armstrong, Whitworth, Sir W. G., & Co., Ltd.	10
Aske, Wm. & Co. Ltd.	12
Atlas Preservative Co., Ltd.	—
August's Muffle Furnaces, Ltd.	14
Badische Maschinenfabrik	23
Bailey, Sir W. H., & Co., Ltd.	28
Baldwins, Ltd.	—
Baxter, W. H., Ltd.	28
Beecroft & Partners, Ltd.	—
Bessler, Waechter & Co., Ltd	—
Bolckow Vaughan & Co., Ltd.	—
Bradley & Foster, Ltd.	—
Brealey, W., & Co., Ltd.	—
Britannia Foundry Co., Ltd.	—
British Aluminium Co., Ltd.	479
British Chemical Standards	—
British Drying & Heating Co., Ltd.	—
British Pigirons, Ltd.	3
Brown, J., & Co., Ltd.	—
Buckley & Taylor, Ltd.	30
Bureau of Information on Nickel, Ltd.	1
Butterworth Bros., Ltd.	—
Cambridge Instrument Co., Ltd.	—
Cammell, Laird & Co., Ltd.	1
Cleveland Magnesite and Refractory Co., Ltd.	27
Coleman Foundry Equipment Co., Ltd.	22
Colville, D., & Sons, Ltd.	29
Consett Iron Co., Ltd.	1
Constructional Engg. Co., Ltd.	—
Corrie, J. B., & Co., Ltd.	21
Cumming, Wm. & Co., Ltd.	—
Cuxson, Gerrard & Co., Ltd.	—
Davidson & Co., Ltd.	—
Davies, T., & Son	5
Dean Bros.	—
Denbigh Engineering Co., Ltd., The	—
Dorman Long & Co., Ltd.	—
Dudley's, Earl of, Round Oak Works, Ltd.	—
Durrans, J., & Sons, Ltd.	—
Dyson J. & J.	—
Electric Furnace Co., Ltd.	—
Evans, J., & Co.	477
Findlay, A., & Co., Ltd.	—
Flexible Shaft Mfg. Co., The	23
Fordath Engineering Co., Ltd.	8
Foster Bros.	—
Foundry & Engineering Co., The	—
Foundry Plant & Machinery Ltd.	—
Furnston & Lawlor	23
Gadd, Thos.	—
General Refractories Co., Ld.	1
Gibbons Bros., Ltd.	24
Giesserei, Die.	—
Goldendale Iron Co., Ltd.	6
Gossell & Son, Ltd.	28
Gray, Thos. E., & Co., Ltd.	—
Green George, & Co.	—
Hall, J., & Co., of Stourbridge, Ltd.	—
Hammond, Alex.	18
Harper, Wm., Son, & Co. (Willenhall), Ltd.	19
Harrison Bros. (England), Ltd.	1
Hawkins, W. T., & Co.	—
Hinckley, J., & Son	—
Hingley, N., & Sons, Ltd.	—
Hope Works Co. The	—
Hunt, F. L., & Co.	—
International Combustion Ltd.	11
International Foundry & Allied Trades Exhibition	—
Jackman, J. W., & Co., Ltd.	2
Jacks, William, & Co.	17
James, Wm.	—
Jones, Geo., Ltd.	—
Keith, James, & Blackman Co., Ltd.	9
King Bros. (Stourbridge), Ltd.	23
Kinnell, Chas. P. & Co., Ltd.	—
Kinrix Foundry Supply Co.	27
Leith, Alexander, & Co.	19
Le Personne, L., & Co.	1
Leyland Motors, Ltd.	—
Lilleshall Co., Ltd.	—
Loagden, G., & Son, Ltd.	—
Lowood, J. Grayson, & Co., Ltd.	480
McNeil, Chas., Ltd.	—
Macdonald, John, & Co. (Pneumatic Tools), Ltd.	—
Macnab & Co.	—
Major, Robinson & Co., Ltd.	21
Mansfield Sand Co., Ltd.	—
Marley Hill Chemical Co., Ltd.	—
Midland Sand Blast and Foundry Supplies Co., Ltd.	—
Mills, Wm., Ltd.	—
Moorwood, Hedley & Co., Ltd.	26
North Eastern Iron Refining Co., Ltd., The	26
Notcutt, Walter P., Ltd.	—
Olsen, Wm., Ltd.	22
Parish, J., & Co.	19
Park Gate Iron & Steel Co.	28
Pearson, E. J. & J., Ltd.	—
Pease & Partners, Ltd.	18
Penman & Co., Ltd.	—
Penney & Porter (Eng.), Ltd.	—
Perry G. & Sons	—
Pickard, W., & Co., Ltd.	—
Pickford, Holland & Co., Ltd.	—
Pittevil & Co.	27
Pneulec, Ltd.	7
Portway, C., & Sons	—
Powell Duffryn Steam Coal Co., Ltd.	—
Pulser, S., & Son, Ltd.	27
Ridsdale & Co.	—
Ritchie, J. & R., Ltd.	—
Robson Refractories, Ltd.	4
Roper, E., & Co.,	—
Rose, J., & Co. (Lime Wharf), Ltd.	—
Ruscoe, John & Co., Ltd.	—
Salter, T. E., Ltd.	—
Sankey, J., & Sons, Ltd.	26
Sankey, J. H., & Sons, Ltd.	21
Sheepbridge Coal & Iron Co., Ltd.	—
Shotts Iron Co., Ltd., The	—
Simm, Martha & Sons, Ltd.	26
Smart, H. & H. B.	28
Smeeton, John A., Ltd.	—
Smith, Edward, Ltd.	—
Smooth-on Mfg. Co.	—
Spermolin, Ltd.	—
Standard Sand Co.	27
Stanton Ironworks Co. Ltd., The	—
Staveley Coal & Iron Co., Ltd.	25
Steel Co. of Scotland, Ltd.	13
Sterling Foundry Specialties, Ld.	1 & 15
Swann, Ratcliffe & Co.	27
Tallis, E.	—
Taylor & Farley	—
Team By-Product Co., Ltd.	19
Tennent, R. B., Ltd.	19
Tilghman's Patent Sand Blast Co., Ltd.	9
Townley, E., & Son	—
Universal System of Machine Moulding & Machinery Co., Ltd.	—
Vereinigte Schmirgel-u. Maschinen-Fabriken, A.G.	—
Vickers, Thos.	19
Walker, I. & I.	—
Wallwork, Hy., & Co.	—
Ward, Thos. W., Ltd.	18
Warner & Co., Ltd.	479
Waring Bros.	—
Watson's (Metallurgists), Ltd.	22 & 28
Wellman Smith Owen Engg. Corporation, Ltd.	29
Welsh Navigation Steam Coal Co., Ltd.	—
Westoby & Rawstron	6
Whittaker, W., & Sons, Ltd.	—
Whittingham, W. M., & Co.	—
Wigan Coal & Iron Co., Ltd.	—
Wild-Barfield Electric Furnaces Ltd.	—
Wilkie, A. H., & Co.	19
Wilkinson, Thos., & Co., Ltd.	—
Williams, John (Birmingham Sand), Ltd.	—
Willson Goggles Inc.	27
Woodward Bros. & Copelin, Ltd.	—

The Simpson Intensive Mixer

The Simpson Intensive Sand Mixer equipped with bucket loader and August Patent Aerator is a sand mixing and preparing plant which not only ensures the maximum efficiency in quality and output of core sand, facing sand and backing sand, but it combines with this certain efficiency the absolute maximum of labour saving.

The raw material is manhandled *only once*, but the sand delivered from the plant is mixed, blended, of the correct temper and bond and also aerated.



[*By courtesy of Messrs. J. & E. Hall, Ltd.*

Messrs. J. & E. HALL, Ltd., have just installed a further No. 1 Size Simpson Intensive Sand Mixer, Bucket Loader and Aerator, identical to the one illustrated here.

AUGUST'S MUFFLE FURNACES, LTD.
HALIFAX.

MISCELLANEOUS.

GANISTER, best quality, for Cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. BUCHANAN & COMPANY, Ashfield Road, Altrincham, Cheshire.

FLUORSPAR.—The ideal Flux for all Foundry and Furnace work; supplied in crude lump, washed gravel or finely ground. Samples and prices from

A. BECK,
MINEOWNER, MATLOCK.

PATTERNS OF ALL DESCRIPTIONS. LARGEST WORKS IN THE MIDLANDS. QUOTATIONS BY RETURN.
G. PERRY & SONS,
HIGHCROSS STREET, LEICESTER.

MISCELLANEOUS.—*Continued.*

D.F.A. BRIQUETTES.—ALL IRON-FOUNDERS should write for particulars of our Desulphurising Ferro-Alloy Briquettes. Sole Patentees and Manufacturers:
SULRON, LIMITED,
FOUNDRY ENGINEERS,
CLOISTER WORKS,
CONGRESS STREET, SHEFFIELD.
Ask for our No. 1 Foundry Bulletin. Sent free on request.

INTERESTED FOUNDRYMEN AND ENGINEERS should be in possession of our Bulletin No. 1, published September 1st. Sent post free upon request. Also ask for our "D. F. A." Briquette List.
SULRON, LIMITED,
CLOISTER WORKS,
CONGRESS STREET, SHEFFIELD

MISCELLANEOUS.—*Continued.*

"SAFETY FIRST" Leather Garments.—Aprons, Spats, Mittens, Hand Leathers for handling pig-iron, etc. See our Catalogue, page 6.

WM. OLSEN, LTD., HULL.

FOUNDRY REQUISITES

Try our REFRACTORIES.

Ganister or Silica Bricks and Blocks (any shape or size)
Sands, Cements, Ganister.—*Let us have your enquiries*

THE
CLEVELAND MAGNESITE & REFRACTORY CO., LTD.
Normanby Brickworks, Normanby, Esten, Yorks

Grain Chill and Steel ROLLS, HEAVY CASTINGS.

IRON up to 100 Tons. *Special Air Furnace.*
STEEL up to 40 Tons. *Siemens' Steel Only.*
R. B. TENNENT, Limited, COATBRIDGE, N.B.

We Specialise in
SAND-BLAST SANDS.
SAND-BLAST NOZZLES.
DUNE SAND FOR CORES.
STEEL SHOT AND GRIT.
FLUXING LIMESTONE.
STRAWROPE. CORE VENTS

THOS. VICKERS, The Foundry Specialists,
14, NEW STREET, BIRMINGHAM.

ERITH LOAM
J. PARISH & CO.,
ERITH.

"AURORA" BURNERS

for
CUPOLA LIGHTING
LADLE DRYING
MOULD DRYING
etc., etc.
COMPRESSED AIR
or
HAND PUMP TYPES
Write for List.

A. H. WILKIE & Co., 78, Duke St., LIVERPOOL

CASTINGS
FOR ENGINEERS, MOTOR TRADES, &c.
Castings Sand-Blasted.

"STAR FOUNDRY"
Birmingham Street, WILLENHALL, STAFFS.
Telephone: No. 25, WILLENHALL.
Telegrams: "STAR FOUNDRY, WILLENHALL."

WILLIAM HARPER, SON & Co. (WILLENHALL) Ltd.
Malleable and Soft Grey Ironfounders.

TEAM BY-PRODUCT COKE CO., LTD.
DUNSTON-on-TYNE
"TEAM" PATENT COKE
SPECIAL FOUNDRY QUALITY

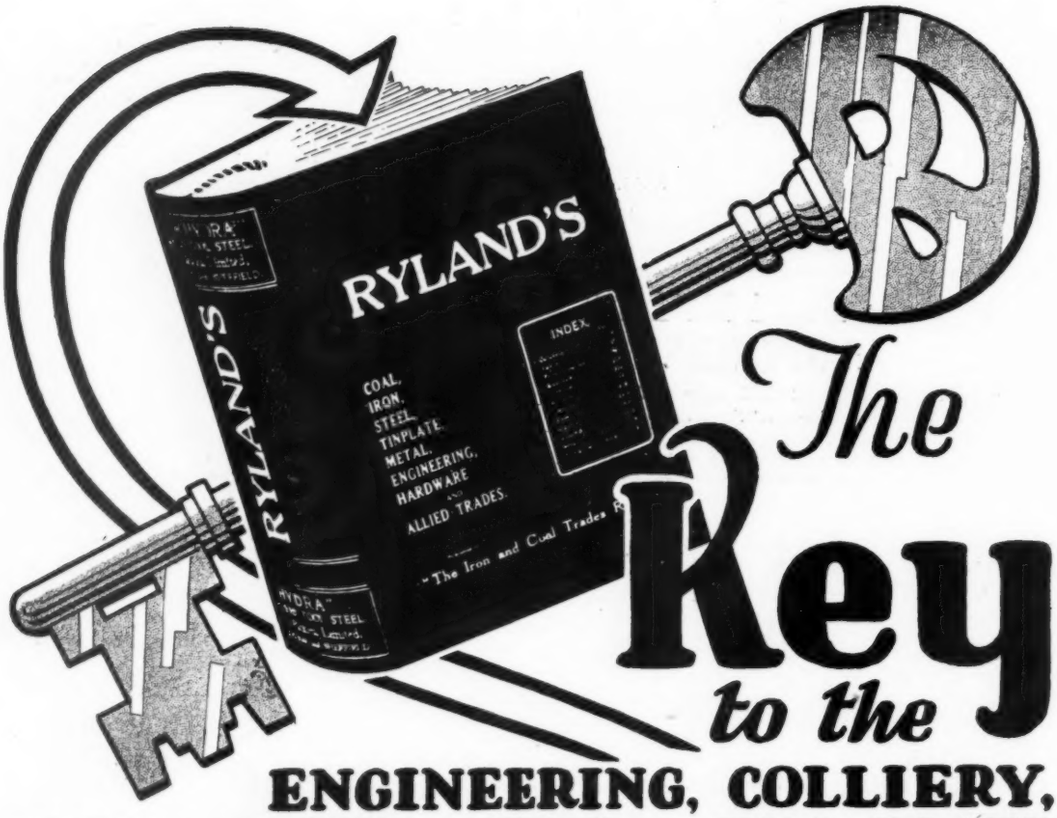
FOR PRICE AND PARTICULARS APPLY TO:—
ALEXANDER LEITH & CO.,
25, COLLINGWOOD STREET,
NEWCASTLE-ON-TYNE.

TYPICAL ANALYSIS (If necessary guaranteed)

ASH	not exceeding	8%
SULPHUR	,, ,,	0·8%
VOLATILE	,, ,,	1 %
MOISTURE	under	1·50%

XUM

1928 Edition



The **Key** *to the*

ENGINEERING, COLLIERY, IRON, STEEL, METAL, TIN-PLATE FOUNDRY, HARDWARE & ALLIED TRADES

More than 25,000 firms in these trades are described in the 2,200 pages of Ryland's Directory.

The standard work of reference for all that concerns the activities of this vast trade group—its pages represent two years' publicity directed solely to interested parties.

NO "WASTE" CIRCULATION.

Price 42/- cloth ; 52/- morocco.

RYLAND'S

1928 EDITION

ORDER NOW.

Published by

THE IRON & COAL TRADES REVIEW

49 Wellington St, Strand London W.C.2

CONTINUOUS MOULDING SCHEMES,
SAND PREPARING AND
HANDLING PLANTS,
COMPLETE FOUNDRY EQUIPMENT.

(SEE LAST WEEK'S AND NEXT WEEK'S ANNOUNCEMENTS.)

Send your enquiries to—

J. B. CORRIE & CO., LTD.

15, Victoria Street, Westminster, S.W.1.

Phone No.: 6940 & 6941 Victoria. Tele. Address: "CORRELATE LONDON."

HARDASTONE

PERMANENT PATTERN COMPOUND

Why has one?

Why has one Malleable and Grey Ironfounder used OVER 52 cwts. of Hard stone Permanent Pattern Compound in the last 3½ months?

Simply because it PAYS! Against all other methods of odd-side, Match and Pattern Plate Production. Hardastone is CHEAPEST, BEST and BRITISH! Compare our prices shown in previous issues.

Also all types of Ferrous and Non-Ferrous Fluxes, Parting Powders, and other Foundry Specialities. Write for prices and details.

A·E·B·PRODUCTS 20 CHEAPSIDE WILLENHALL

M SCOLS R TRADE MARK

IRON & STEEL CEMENTS

AWARDED DIPLOMAS and MEDALS by the ROYAL SANITARY INSTITUTE, LONDON.

3 GRADES

ALL BRITISH CEMENTS

A WHITE LABEL

B BLUE LABEL

C RED LABEL

Full particulars upon request.

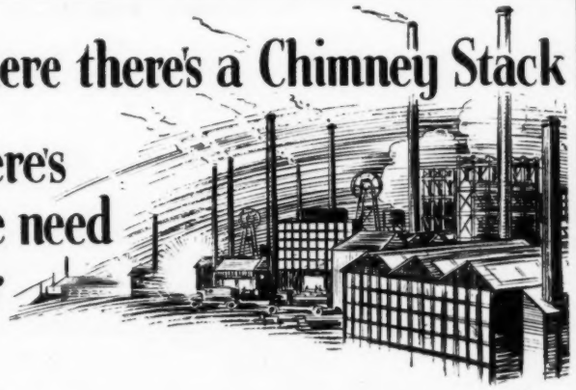
Sole Manufacturers—

MAJOR, ROBINSON & Co. Ltd.

385 & 387, CITY RD., CORNBROOK, MANCHESTER.

'Phone: Trafford Pk. 1760 Telegrams: "Blowpipe, Manchester."

Where there's a Chimney Stack there's the need for



"Fosalsil" (REGD.) (Moler) BRICKS

Millions of tons of Fuel are wasted every year through loss of heat where Chimney Stacks are in use. Therefore, heat conservation through adequate insulation is a vital problem. Fortunately this problem has been most efficiently solved by the discovery of a diatomaceous earth composed of minute cells of still air sealed by nature.

Practical tests have decisively proved that FOSALSIL (Moler) is superior in all respects to any other Insulating Material whether natural or artificial.

Efficient Insulation.

Not only does FOSALSIL (Moler) afford the most efficient insulation effecting great economies in Fuel but it also considerably reduces constructional costs.

FOSALSIL (Moler) is proving a great economic factor throughout the Country to Steel Works, Gas Works, and other Industrial Buildings.

Made up in Brick form, it is largely used for Boiler Insulation, Kilns, Gas Producing Plants, Refrigerating Plants, Boiler Furnace Flues, Glass Furnaces, etc., etc., and it is computed that in some cases, no less than 60-70 per cent. of heat loss can be saved.

Fosalsil Composition for Pipe and Boiler Covering

FOSALSIL (Moler) is also available in the form of Composition for the Insulation of Steam and Water Pipes, Boilers, Furnaces, Tanks, etc., both high and low temperatures.

[**A Brochure giving full information with Samples, Technical Data, and particulars of Laboratory Tests, etc., will be gladly sent to anyone making enquiries.**]

J. H. SANKEY & SON, LTD.

(CANNING TOWN)

MANUFACTURERS OF "PYRUMA" FIRE CEMENT

7/8, Norfolk St., Strand, London, W.C.2

Sole Selling Agents for

MOLER PRODUCTS LTD.

WORKS NEAR COLCHESTER.

GRAPHITE ELECTRODES OF UNIFORM HIGH QUALITY FOR THE PRODUCTION IN THE ELECTRIC ARC FURNACE OF ALL KINDS OF STEELS, GREY IRON, ZINC, BRASS, ETC.

ACHESON ELECTRODES

WRITE FOR INFORMATION TO:
E. G. ACHESON, LTD.,
40, WOOD STREET, WESTMINSTER, S.W.1
Telephone: FRANKLIN 6120-1 Telegrams: OILDAG PARL, LONDON.

CORE and WRAPPING ROPINGS

IN ALL VARIETIES

STRAW AND WOOD WOOL ROPES

WOOD WOOL in BALES *For Packing Purposes*

VARIOUS GRADES FROM 8/- CWT.

WILLIAM OLSEN, LTD., Cogan Street, HULL

COLEMAN FOUNDRY EQUIPMENT CO., LTD.

Telegrams: "COLMAMOULD, RAND, LONDON." *(Foundry Specialists)* Telephone: TEMPLE BAR 8165.

1, Lancaster Place, STRAND, LONDON.

MOULDING MACHINES. SAND DRESSING MACHINES. SAND BLAST EQUIPMENT.

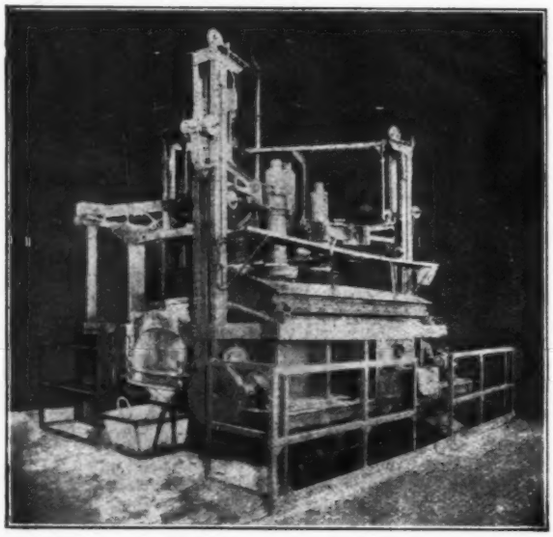
EVERYTHING FOR THE FOUNDRY.

GREAVES-ETCHELLS ELECTRIC STEEL FURNACES

MORE THAN 100 FURNACES SUPPLIED DURING LAST 7 YEARS.

WATSON ROTATING ELECTRIC FURNACES Ensure RAPID & CLEAN MELTING

THOROUGH MIXING.



NON-FERROUS METAL MELTING ELECTRIC FURNACES

SINGLE, TWO, or THREE PHASE.

CONTRACTORS TO HOME AND FOREIGN GOVERNMENTS.

WATSONS (METALLURGISTS) LIMITED

Lancaster Street, SHEFFIELD.

KING Bros.

(Stourbridge), Ltd., STOURBRIDGE, England.

Telegrams: "KING BROS., STOURBRIDGE."

STOURBRIDGE CLAY.

THE HIGHEST AWARDS for GAS RETORTS and other goods (in Fire Clay) have been awarded to KING BROTHERS for their goods made from their renowned STOURBRIDGE FIRE CLAY.

MANUFACTURERS OF

CUPOLA BRICKS, Best *QUALITY*.
Lessees of *DELPH* and *TINTERN ABBEY BLACK* and *WHITE CLAY*.
BRICKS FOR REGENERATIVE SETTINGS.
BLAST FURNACE LININGS.
COWPER and other *HOT AIR STOVE BRICKS*.

Coke Oven Bricks a speciality.

PATTERNS

in WOOD & METAL
for all branches of ENGINEERING.

□ □

We have a shop specially built and equipped for the economical production of Patterns.

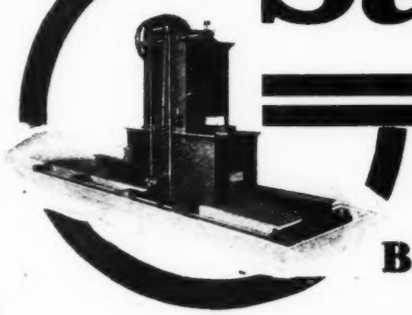
ALSO

Castings in Aluminium, Brass and Gunmetal.

□ □

FURMSTON & LAWLOR
LETCHWORTH.

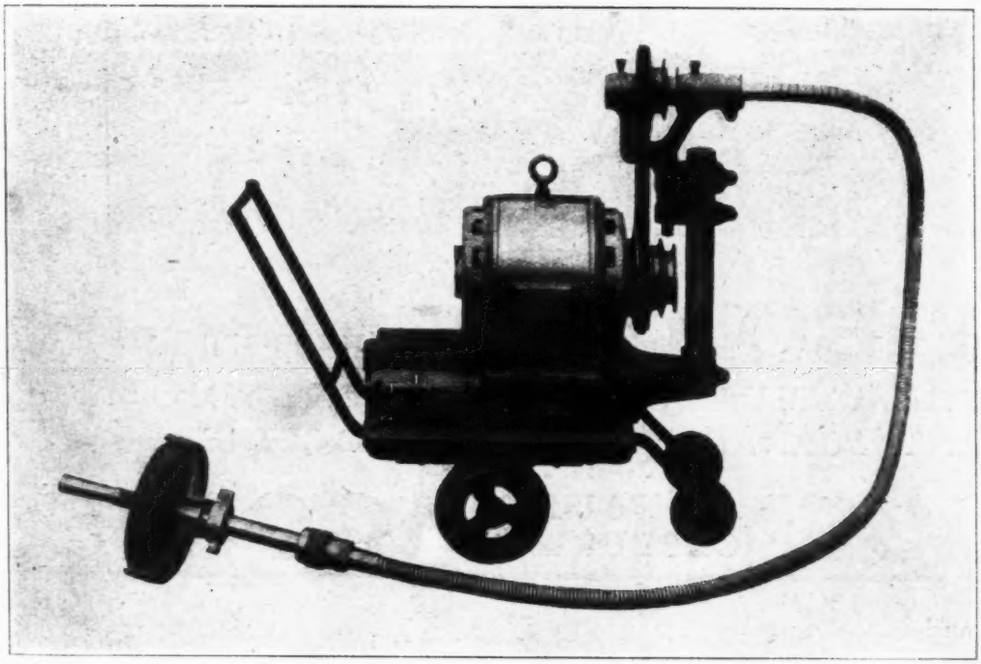
Sandblast machines



We construct any sort of Sandblast Machines to suit any want aimed at and which can be driven with quartz, as well as with steel-sand. The apparatus shown here is used for cleaning rolled iron of any section. It is advised in order to get a more advantageous working to let go through the machine several bars at the same time. The output amounts to about 40 square metres of skinned surface for each hour and it is possible to blast rolled sections up to a height of 40 centimetres.

Badische Maschinenfabrik
Durlach, Germany (established 1854)

Agents: S. INGRAMS & Co., Finsbury Pavement House, Moorgate, London, E.C.2.



The
"SUPER"

Complete Portable MOTOR-DRIVEN EQUIPMENT
(ALL BRITISH.)

1½ H.P. motor and starter, mounted on a rubber tyred trolley with teak base—steel column mounted on special cast iron base with bracket and clamp for belt adjustment and 3-speed pulleys.

Coupled to 8 ft. Flexible Shaft with $\frac{11}{16}$" inner core, aluminium guard and 8" × 1" emery wheel with outer ball bearing detachable handle.

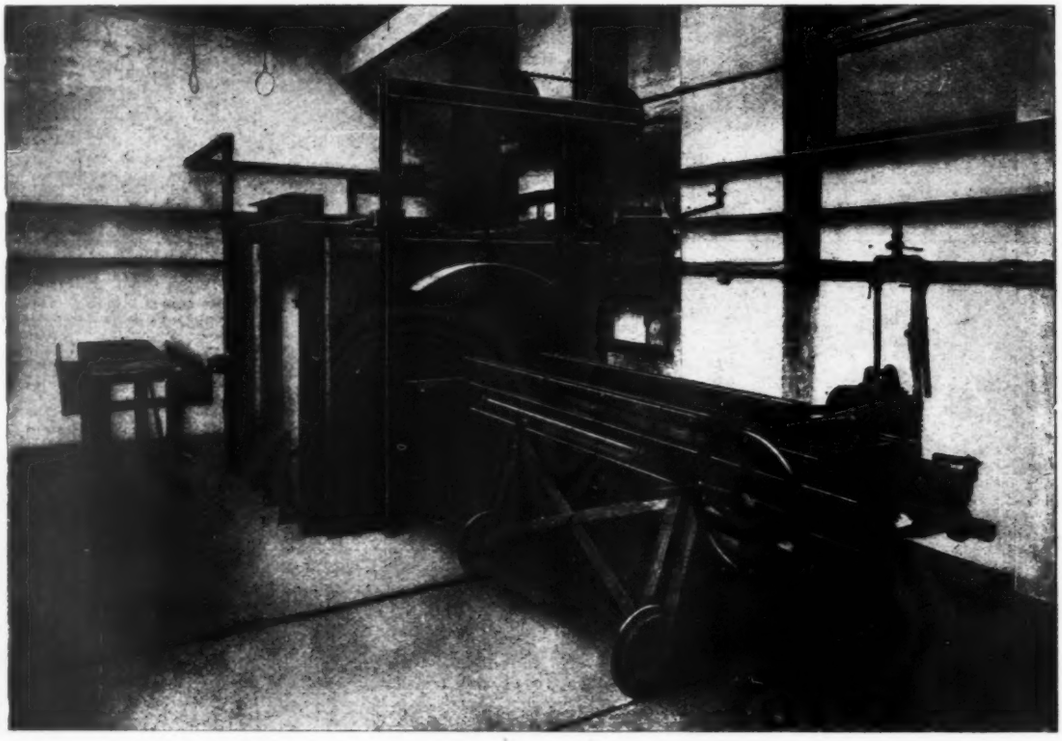
All wired ready for use with 12' of 3-core cab tyre cable and 3-pin plug and socket.

Write for particulars of drilling press for drilling with this outfit up to 1¼" in steel.

The FLEXIBLE SHAFT MANUFACTURING CO.
TOWN ROAD, EDMONTON, LONDON, N.9
CONTRACTORS TO THE ADMIRALTY, AIR MINISTRY, ETC.

XUM

HEAT TREATMENT
UNDER
IDEAL CONDITIONS



GIBBONS'S NEW PATENT
REGENERATIVE GAS FURNACE AND
PATENT FURNACE CHARGING MACHINE

REDUCE ANNEALING & CARBURIZING **COSTS**

Illustrated Lists and
Full Particulars from:

GIBBONS BROS. Ltd., Dibdale Works, DUDLEY, WOROS.

COAL
Annual Output 4 million tons

PIG IRON
For General Foundry and Forge Purposes

CAST IRON PIPES
For Water, Gas, Steam, Sewage and Hydraulic Power.

THE STAVELEY
COAL & IRON Co Ld

HEAD OFFICE & WORKS **CHESTERFIELD.**

Head Office and Works—Telegrams: "STAVIRON, HOLLINGWOOD." Telephone: STAVELEY 7201

London Office: CROWN HOUSE, ALDWYCH, W.C.2

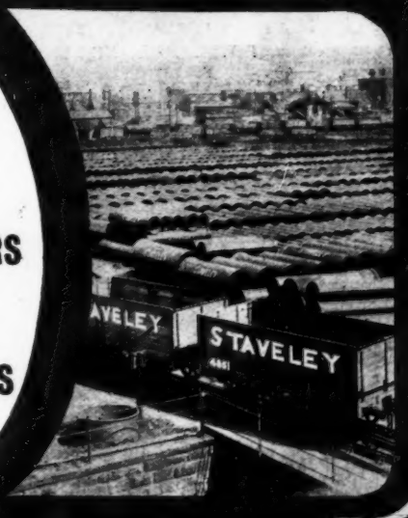
Telegrams: "Stavironco, Estrand, London." *Telephone: Regent 4846 (2 lines).*

TAR DISTILLERS AND CHEMICAL MANUFACTURERS

ACIDS

SODA PRODUCTS

ETC.



ESTABLISHED OVER 110 YEARS.

MARTHA SIMM & SONS LTD

Nuns Lane Mills, GATESHEAD-on-TYNE

Manufacturers of

IRONFOUNDERS' BLACKINGS

DURHAM COAL DUST, CHARCOAL, &c.

IMPORTERS OF

FINEST CEYLON PLUMBAGO

ENQUIRIES SOLICITED

Telegraphic Address: "BLACKINGS GATESHEAD."
Telephone No.: 740 GATESHEAD.

"Long Sought For —Now Found." "FOUNDRITE" TRADE MARK *THE MATERIAL.*

FOUNDRITE

Found Right, and is the Only true Binding Material in Use ALL OVER THE WORLD. No Up-to-Date Foundry is Run without It. When you Try it you have Economy.

Agents for:—
DORMAN LONG & CO., LTD.
"B.S. HEMATITE PIG-IRON."

CORE BINDER PREVENTS WASTERS.

SUPPLIED ONLY IN 40-GALLON CASKS.

HEDLEY MOORWOOD & Co., Ltd.,
FOUNDRY EXPERTS,
ROYAL INSURANCE BUILDINGS,
32, CHURCH STREET, SHEFFIELD.
Telegraphic Address: "MOROD, SHEFFIELD." *Telephone:* SHEFFIELD 26018.

PRESSED STEEL FOUNDRY LADLES

SANKEY'S have an organisation and plant completely equipped to supply you with seamless one-piece foundry ladles of every type. Made in pressed steel or other materials, and in any capacity from ¼ cwt. to 15 cwts., these ladles can be supplied plain or lipped, according to your requirements.

May we quote for your order? We guarantee quick delivery.

JOSEPH SANKEY & SONS LTD
HADLEY CASTLE WORKS · WELLINGTON
SHROPSHIRE

Telephone No.: 12 STILLINGTON. Telegrams: "REFINERY, SEDGEFIELD."

REFINED PIG IRONS

CHILLING QUALITIES AND LOW CARBON IRONS
FOR
CYLINDERS AND OTHER SPECIAL WORK *BRAND* "N.E.C."

REFINED PIG IRONS *for* MALLEABLE CASTINGS. *BRAND* "N.E.M."

THE NORTH EASTERN IRON REFINING CO., LTD., STILLINGTON :: STOCKTON-ON-TEES

Buy the Best and Be Prouder Still.

For Reduction of Costs, the Elimination of Wasters, and the obtaining of the most Pleasing External Appearance, the World famous "SILICA" Natural Steelfounders' Moulding Sand is unequalled.

PITTEVIL & CO., 22/23, Laurence Pountney Lane, E.C.4.

Telegrams: "Swann, Brassington."
Telephone: Wirksworth 30.
Registered Office: **BRASSINGTON,** near Wirksworth, Derbyshire.

SWANN RATCLIFFE & Co.

Manufacturers of High Temperature Refractory Materials.
SPECIALITIES:—Siliceous Fire Bricks and Aluminous Bricks for the Stoker Arches of Babcock & Wilcox and Stirling Boilers, Siemens Furnace Chamber Walls, and Chamber Arches, etc., also specially suitable for the Crowns and Arches of Soaking, Puddling, Re-heating Furnaces, and Gas Works. Especially suitable for Cupola Lining. Raw White Derbyshire and Ground Ganisters — Siliceous Firecla.s, etc.
PLUTO FIRE CEMENT.
FURNACE CONSTRUCTIONAL ENGINEERS.

Contractors to Admiralty. On War Office List.
Works: **BRASSINGTON,** near Wirksworth, Der.yshire.

ERITH MOULDING SAND AND LOAM

KINRIX FOUNDRY SUPPLY CO., 199, Warwick Rd, London, W.14. (*Phone: 0273 Western.*)

FOUNDRY REQUISITES
Try our REFRACTORIES.
Ganister or Silica Bricks and Blocks (any shape or size).
Sands, Cements, Ganister.—*Let us have your enquiries.*
THE CLEVELAND MAGNESITE & REFRACTORY CO., LTD.,
Normanby brickworks, Normanby, Eston, Yorks.

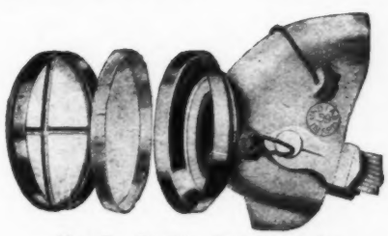
WORLD FAMOUS MOULDING SANDS

MANSFIELD STANDARD SANDS for CASTINGS in IRON, BRASS & ALUMINIUM.
Tel. 201. *Pulverised ready for use.*
STANDARD SAND CO., Ltd., MANSFIELD.

CORNISH MOULDING SAND and CORNISH SILICA CLAY for STEEL CASTINGS.
Tel. 201.
CORNISH SAND CO., MANSFIELD.

WILLSON DUSTITE RESPIRATOR AND SAFETY GOGGLES.

No. L70.—For oxy-acetylene welding. A good Fibre-Goggle, well ventilated, adjustable, with Willson Sweat-Proof Padding. Furnished with industro glass.



No. 2.—Dustite Respirator for dusty work and spraying. Allows comfortable breathing.

No. L31½.—For Chipping, Riveting, Scaling and similar work. Fitted with Willson Super-Tough Glass.

S. PULZER & SON, LTD., Sole Importers for Great Britain. **45, Hatton Garden, London, E.C.1**

GOSSELL & SON, LTD.

110, CANNON STREET, LONDON, E.C.

Telephone No.:—CITY 6754. Telegraphic Address:—"GOSSOTTO, LONDON."

Specialities:—

Rails, Tram Rails, Steel Sleepers, Steel Joists to 24 in. deep. Channels, Angles, Bars, Sheared Plates, Flitch Plates to 36 in. wide, &c.

Bridgework, Constructional Ironwork and Locomotives, Special Steel Castings, Rolling Stock.

BAXTER'S

Patent Knapping Motion

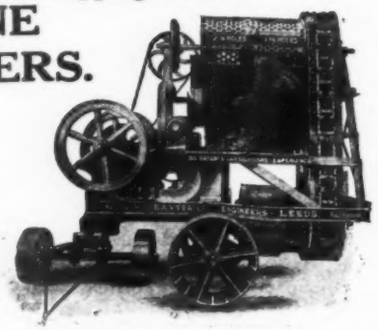
STONE BREAKERS.

UNEQUALLED

Sole Makers:—

W.H. BAXTER, LTD.

LEEDS.



FERRO-ALLOYS

OF EVERY ANALYSIS FOR ALL PURPOSES.
IMMEDIATE DELIVERY FROM LARGEST STOCKS IN U.K.

FERRO { CHROMES, SILICONS, TUNGSTEN, MOLYBDENUM, MANGANESE, COPPER, TITANIUM, PHOSPHORUS, VANADIUM, ALUMINIUM, TANTALUM, COBALT, Etc.

METALS { TUNGSTEN, NICKEL, COBALT, CHROMIUM, COPPER, MANGANESE

ORES, MINERALS, ETC.

WATSONS (Metallurgists) LTD.

Head Office: LANCASTER STREET, SHEFFIELD.
London Office: 8, SOUTHAMPTON ROW, W.C.1.
Works: PLATT STREET, NEEPSEND, SHEFFIELD.

SUPERIOR SILICA BRICKS

FINE SILICA CEMENT.

TRADE MARK—R. DINAS.

H. & H. E. SMART, KIDWELLY

BAILEY'S

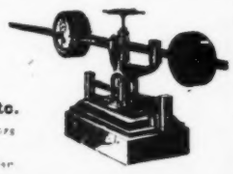
TRANSVERSE TESTER

FOR THE FOUNDRY.

Tests Bars of Cast Iron, Bronze, Etc.

Testers for all Materials, Oils, etc. Air Compressors Pumps, Reducing Valves.

SIR W. H. BAILEY & CO., Ltd., Manchester



BRAND
PARKGATE YORKSHIRE STEEL

Works Established 1823

BRAND

THE PARK GATE IRON & STEEL CO.,

LIMITED.

Rotherham, England.

MANUFACTURERS OF HIGH CLASS STEEL BY SIEMENS PROCESS ONLY.

STEEL PLATES

For Marine, Lancashire, Locomotive, Land, and other Boilers; also Bridge and Tank Plates, Sheets, Chequered Plates.

STEEL BARS

In Rounds, Squares, Flats, Angles, Tees, and Sectional Bars of all descriptions
Special Bars for Ferro Concrete

HIGH TENSILE STEEL

In Plates, Sheets, and Bars.

SLABS AND BILLETS, DEAD SOFT, AND GUARANTEED CARBONS. WELDING AND CASE HARDENING STEEL.

STEEL SUPPLIED TO ADMIRALTY, WAR OFFICE, BOARD OF TRADE, LLOYDS, ENGLISH AND FOREIGN RAILWAYS.

PIG IRON, Foundry and Forge Brand "P.G. LINCOLN."